DEPARTMENT OF TRANSPORTATION

Tailgate Test Kit for Determining Appropriate Sediment Reducing Chemicals and Dose Rates

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Wenck Associates, Inc.

July 2017

Research Project
Final Report 2017-32

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Tailgate Test Kit for Determining Appropriate Sediment Reducing Chemicals and Dose Rates

FINAL REPORT

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EXECUTIVE SUMMARY

This study develops a Tailgate Test Kit to be used in the field to test flocculants for reducing turbidity in construction stormwater discharge. Turbidity of stormwater runoff at construction sites varies depending on which site soils are exposed to erosion. Previous research shows that the effectiveness of different flocculants also varies depending on the site soils. As the name suggests, the Tailgate Test Kit is a mobile means to efficiently determine which of the numerously available flocculant products works well for a particular construction site.

Thirteen flocculant products of various classifications were obtained from product representatives. Stormwater samples from eight different sites were collected for product testing to develop product mixing and dosing guidance. Initially, worksheets with mixing and dosing guidance were developed for the 13 products. The worksheets help identify the effective product dose to achieve the target turbidity goal. Scaling procedures are provided to guide converting the test results into the dosing rates for full scale product application.

Based on testing results of 13 products, a shortened list of five tests was recommended for use in the Tailgate Test Kit. These five tests provide a range of flocculant product classifications while greatly reducing the testing time required. If new products are to be considered for the Tailgate Test Kit, procedures to test these products are provided.

Four methods for testing residual/unreacted products were investigated based on suggestions from product representatives and research. Observations were made during product testing which raised several questions regarding the feasibility of these methods for testing residual product. A preferred method was not identified for use in the Tailgate Test Kit. It is recommended that residual testing is investigated further. Suggested methods include:

- Mixing untreated sample with product-treated sample
- Individual product residual tests
- Maximum product dosing limits
- Environmental stress indication test

In addition to further investigation of residual testing, it is recommended that testing of new products be continued as they are developed and funding exists.

CHAPTER 1: INTRODUCTION

1.1 PROJECT OBJECTIVES

The research presented in the following report was conducted to develop a Tailgate Test Kit to be used for field testing flocculant products for reducing turbidity in construction stormwater discharge. The specific objectives include:

- Develop an on-site Tailgate Test Kit to be used to test flocculant products on construction stormwater discharge.
- Develop dosing and mixing guidance for testing the flocculant products.
- Develop guidance for determining an effective product dose to meet target turbidity goals. The effective dose can also be used to evaluate cost effectiveness for full-scale product application to construction stormwater discharge.
- Develop a procedure to scale product test results to full-scale product application to construction stormwater discharge.
- Develop a method for testing/detecting residual/unreacted products in construction stormwater discharge to reduce the potential for overdosing.
- Provide guidance to prevent overdosing, and what actions to take if product spillage occurs.

1.2 PRODUCTS TESTED IN STUDY

The flocculant products used in this study were identified based on the following:

- Input from the Technical Advisory Panel (TAP) included MnDOT staff, a representative from a watershed district, and other consultants;
- Review of previous research by Dreschel (2014); and
- Review of other state Department of Transportation (DOTs).

Appendix A provides a review of previous research.

The product list was developed to represent a variety of products, and product types, to adequately test and develop the "Tailgate Test Kit." Since products, or product types, may vary in effectiveness on different soil types and environmental conditions, the product list was created to include a range.

The product manufacturers were contacted to discuss their products and to identify the best product to include in this study. Based on the manufacturer recommendations, the products identified for use in the study are detailed in Table 1.1.

Table 1.1 Products Identified for use in the Tailgate Test Study.

Product Name	Manufacturer	Product Classification/Family[1]
FLOC 06	Innovative Turf Solutions	Mineral
SCI CW-A0	Standard Contracting	Mineral
Earth Poly-Stable Plus	Earth and Road	Polyacrylamide
Liquifloc 1%	Dober	Chitosan
LBP 2101	Dober	Biopolymer
Biostar-CH 2%	Hild and Associates	Chitosan/Biopolymer
APL Bridger	Hild and Associates	Polyacrylamide
APS 703d#3 Floc Log	Applied Polymer Systems, Inc.	Anionic Polyacrylamide
APS 706b Floc Log	Applied Polymer Systems, Inc.	Anionic Polyacrylamide

[1] The product classification/family for each product was provided by the product manufacturers.

This list is not a comprehensive list. It is recommended that additional products be tested and considered for use in the Tailgate Test Kit as funding allows.

1.3 SAMPLES INFORMATION

There were eight samples collected to test the products and help develop the Tailgate Test Kit. Samples were collected from a variety of locations throughout Minnesota that provide varying test conditions (specifically soil type and possibly other environmental factors). The eight samples are described in Table 1.2. Figure 1.1 shows the locations of the samples.

Table 1.2 Samples Tested.

Sample ID	Location	Initial Turbidity (NTU)[1]	Number of Products Tested
Test Sample	Synthetic sample made from pond sediments	~1000[1]	13
Sample 1	From a discharge hose at a St. Croix River construction site	~1000[1]	13
Sample 2	From a discharge hose at a Hwy 53 (northern MN) construction site	~1000[1]	13

Sample ID	Location	Initial Turbidity (NTU)[1]	Number of Products Tested
Sample 3	From a discharge hose at a St. Paul Technical College construction site	Significantly greater than 1000	13
Sample 4	Created from a soil sample and water collected at a Hwy 371 (central MN) construction site	~500	13
Sample 5	Grab samples from three separate BMPs from a Hwy 36 and Lex. Ave. construction site in Roseville.	~100, 280, and >1000	5 (onsite testing with the Tailgate Test Kit)
Sample 6	Grab sample from a Hwy 96 (north metro) construction site runoff	~500	5 (onsite testing with the Tailgate Test Kit)
Sample 7	Synthetic sample made a Nemadji River construction site soil and distilled water	>1000	5

[1] At the time of testing the sample, the turbidity meter that was used was later identified to not provide reliable measurements greater than 100 NTU. The sample was not able to be tested with a turbidity meter with a range up to 1000 NTU, but based on sample observations the initial turbidity was estimated at approximately 1000 NTU. Although the turbidity meter measurements greater than 100 NTU were not reliable and were excluded, the measurements less than 100 NTU were reliable and included.

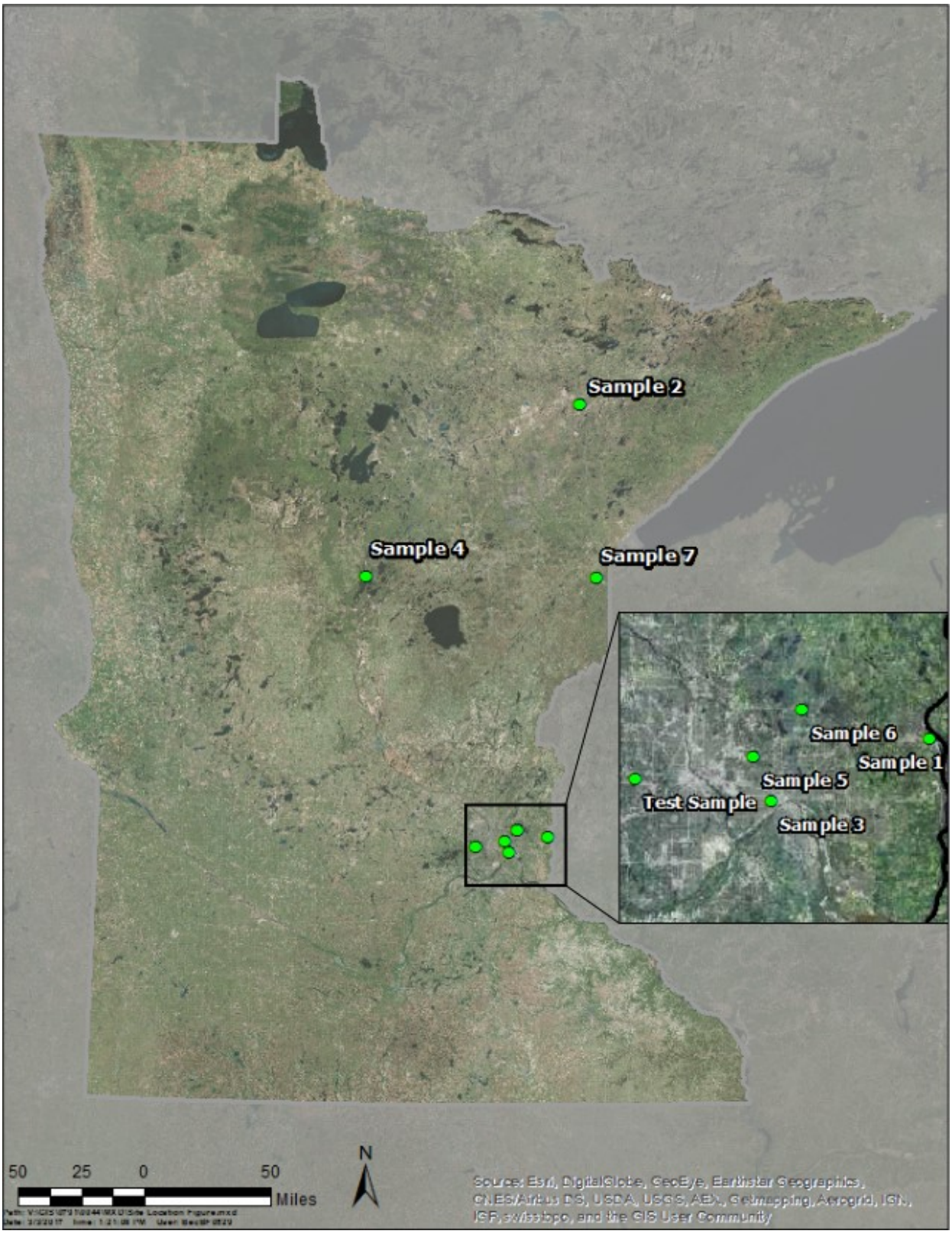

Figure 1.1 Sample Locations.

CHAPTER 2: METHODS

This section provides the following information:

- A description of the development of the Tailgate Test Kit,
- The methods and guidance on performing the tests,
- Steps to develop a new product test,
- Scaling test results to full scale product application, and
- An evaluation of product residual.

2.1 TAILGATE TEST KIT DESCRIPTION

The Tailgate Test Kit is a mobile field kit for performing bench test scale product tests to identify effective flocculant products that can be scaled to treat construction stormwater discharge. A detailed description of the Tailgate Test Kit that was developed for use in this study is provided in Appendix B. The important items are listed below.

- A turbidity meter.
- Sample/test containers.
- Dose measurement tools.
- Field documentation worksheets.
- The products to be tested.
- Personal protective equipment (PPE).

Additional items that are not necessary to perform the product tests, but are helpful with conducting the tests include:

- Timer or stopwatch.
- Meter for pH and temperature.
- Mixing utensils to mimic full scale mixing method.
- Storage containers for organization.
- Supplies for cleaning the testing equipment and garbage collection.

2.2 TESTING METHODS AND PRODUCT TEST WORKSHEETS

The primary purpose of the Tailgate Test is to answer the following questions:

- What product(s) work to reduce the turbidity of construction stormwater discharge to achieve the turbidity goal?
- What is the effective product dose?

To help answer these questions, worksheets were created for 13 tests show below that include mixing and dosing guidance, data collection tables, and space for observation notes or calculations.

- Test 1 – Control (No Products Tested)
- Test 2 – Floc 06
- Test 3 – SCI-CW-A0
- Test 4 – Earth Poly-Stable Plus
- Test 5 – Liquifloc 1%
- Test 6 – LB2101 (first) then Liquifloc 1% (second)
- Test 7 – Biostar-CH 2%
- Test 8 – APL Bridger
- Test 9 – Biostar-CH 2% (first) then APL Bridger (second)
- Test 10 – APL Bridger (first) then Biostar-CH 2% (second)
- Test 11 – APS 703d#3 Floc Log
- Test 12 – APS 706b Floc Log
- Test 13 – APS 703d#3 Floc Log and APS 706b Floc Log (Simultaneously)

The worksheets for the 13 tests are provided in Appendix C.

In general, performing a product test worksheet typically takes between 30-60 minutes depending on test results. Due to the time necessary to complete the test worksheet for each product, a shortened list of five tests is proposed for use in the Tailgate Test Kit. This list was developed based on test results and observations. The worksheets for the five tests proposed for use in the Tailgate Test Kit are available in Appendix D. The shortened list of tests includes:

- Test 1 – Control (No Products Tested)
- Test 2 – Floc 06
- Test 3 – SCI-CW-A0
- Test 5 – Liquifloc 1%
- Test 7 – Biostar-CH 2%

Specific guidance for each test is provided in the worksheets of Appendices C and D. A typical test is summarized in the following steps.

- Collect a sample for testing that is representative of the construction stormwater discharge that is to be treated. Ideally, this would be a sample from the end of the discharge hose. Collect enough sample to complete all the tests expected to be performed. Once collected, separate the sample into the testing containers (one for each product/test).
- Begin completing the worksheets for each test. It is important to complete Test 1 which is the control. This establishes the initial sample conditions that can be used to compare to the product tests results.
- The first step to complete for each product test is the “Rapid Test” check. The Rapid Test is simply a check to see if the product will work and is completed by overdosing the sample with large amounts of the product to see if a reaction occurs. A visual observation is made to determine if the product will provide results that can meet the target goal.

- Once the Rapid Tests are completed, perform the “Dosage Estimation Test” for the products that appear to work on the sample. When performing the “Dosage Estimation Test” for each product, follow the mixing and dosing guidance on the test worksheets.
- Each dose/mixing step includes adding a dose of the product, mixing the product, and letting sit for typically 30 seconds to 1 minute. At the end of the 30 seconds to 1 minute, if a reaction is noticed, the sample needs to be undisturbed to allow for settling for approximately 5 minutes. After 5 minutes, a turbidity measurement can be collected to compare to the target turbidity goal. If no reaction is noticed at the end of the 30 seconds to 1 minute, then repeat an additional dose/mixing step until target turbidity levels are met.
- A turbidity measurement is collected after a reaction is noticed by pipetting or decanting a portion of the sample into a cuvette or test tube to be measured by a calibrated turbidity meter.
- The incremental dose/mixing steps allow for a dose-turbidity curve to be generated which can be used to identify the effective product dose necessary for full scale application. It is important to record the cumulative doses that have been added and the corresponding turbidity measurements so this curve can be generated.
- After the test has been completed, it is beneficial to measure the final pH and temperature of the sample.

Once the tests are completed and results are evaluated, the product(s) that work and the effective doses are identified. The results can then be used to scale up for treatment of the construction stormwater discharge to meet turbidity goals.

2.3 SCALING TEST RESULTS TO FULL SCALE APPLICATION

The Tailgate Test Kit provides the tools needed to complete the product test worksheets that help identify the effective dose to meet target turbidity goals. Ultimately, the test results are scaled to treat construction stormwater discharge. The difficulty in scaling test results is to convert the test result to the proper dosing rate for application to the construction stormwater discharge. A detailed procedure for scaling the test results are included as Appendix E. The following summarize the scaling process:

- Determine/estimate the total volume of water to be treated.
- Identify the construction stormwater discharge rate that is going to be treated.
- Select the product to use.
- Identify the effective product dose needed to treat the sample volume.
- Estimate total product needed to treat the total volume to target turbidity goal.
- Estimate the product dose rate to treat the construction stormwater discharge rate.
- Monitor reduction results during full scale product application. Adjust dose rate as necessary to achieve target turbidity goal.

If several products were determined to be effective, the total amount of each product required coupled with its respective cost can be used to identify the most cost-effective option.

2.4 FLOCCULATION BEST MANAGEMENT PRACTICE

During full scale product application, flocculation products can be applied through many application methods to treat high turbidity construction stormwater discharge. Some of the delivery and application methods include:

- Directly applying product to the surface of a storage BMP (mixing mechanism may be required;
- Direct injection to surface flow and/or pipe flow; and
- Passive dosing installed instream, within a conveyance system or at a concentrated discharge point like an inlet.

The effectiveness of each delivery method is the result of the associated mixing process. It is important to test and mix the flocculants in the tailgate test similarly to the mixing that is anticipated during large scale application.

After product application, the treated discharge should be routed to a settling BMP to allow floc particles to settle prior to discharging to the downstream water body. Based on test observations from this study, it is also recommended that a filter is incorporated into the floc removal plan located after the settling BMP. See links in Appendix A to diagrams of dosing methods.

2.5 NEW PRODUCT WORKSHEET DEVELOPMENT AND TESTING

It was not feasible to test all products in the Tailgate Test Kit Study. The procedure to test new products was developed so that additional products can be tested and included in the Tailgate Test Kit in the future. The detailed steps for testing a new product are included in Appendix F. An overview of this procedure is provided below.

- Contact manufacturer to obtain a sample of the product.
- Obtain available product information from the manufacturer including Material Safety Data Sheet (MSDS), and mixing and dosing guidelines.
- Begin testing of new product following manufacturer mixing and dosing guidelines.
- Typically, first a product dose is added to the sample, the sample is mixed, and then the sample is observed for a reaction. The specific testing steps will depend on product and manufacturer recommendations.
- If a reaction is noticed, a turbidity measurement should be collected for developing dose-turbidity curves.
- Repeat the dose, mixing, observation, and turbidity measurement as needed to achieve the target turbidity goal.
- Repeat test on multiple stormwater samples (typically 3-5, but as needed) to develop the dosing and mixing recommendations.
- After testing the samples, review the results and make a determination if a worksheet should be developed for the product and included in the Tailgate Test Kit.

- The worksheet should include the mixing and dosing guidance, and a data table. Review other product worksheets for guidance.
- Identify the product weight conversions that are helpful with scaling test results to full scale product application.

Once the product has been tested and a worksheet developed for field testing, the product can be included in the Tailgate Test Kit.

2.6 RESIDUAL/UNREACTED PRODUCT TESTING

Creating a residual test to detect unreacted product in the construction stormwater discharge reduces the chance for overdosing at full scale applications. Four methods for testing residual/unreacted product were investigated and discussed below.

2.6.1 Residual Testing by Mixing Untreated Sample with Product Treated Sample

The idea of mixing untreated sample with the product treated sample is if a reaction occurred, this would indicate that residual product is present. This test method would require knowing the untreated sample turbidity, the product treated sample turbidity, and an accurate estimate of what the combined turbidity should be prior to a reduction due to residual product (if any) after mixing the two together. The feasibility of this method as a reliable residual test became questionable after testing the products on several samples. Observations were made that may not make this method feasible for testing residual product. These observations include:

- For many of the samples, a reaction was not noticed or measurable until enough incremental product doses were added to cause a significant reaction.
- After a reaction was noticed, the turbidity measured was dependent on the time allowed for settling of floc particles.

These observations generate questions regarding the feasibility of this method as a residual test. It is not clear if the observations mean a threshold dose may be required before a measurable reaction occurs. If this is the case, there may be residual product, but not enough to cause a measurable reaction. Also, does the product bind to particles when no reaction is observed and there just isn't enough product to generate larger floc reactions, or is the product not binding to the particles until enough product is dosed to cause a reaction? For both scenarios, the residual test method described above would not identify residual product because a measurable reaction does not occur.

The time that is allowed for settling of floc particles prior to a turbidity measurement does impact the turbidity measured. A turbidity measurement taken after a short settling time is higher than compared to a turbidity measurement taken after a longer settling time. This means that it may be difficult to distinguish between a reduction due to a residual reaction, or a reduction due to the settling time prior to testing the turbidity of the mixed samples (untreated mixed with treated). After mixing the samples, time will need to be allowed for the reaction (if any) and subsequent settling of floc to occur prior to

turbidity measurement. Therefore, it may be difficult to determine if there is residual product with this method.

2.6.2 Individual Product Residual Tests

Based on conversations with product manufacturers, there may be specific residual tests for each product, or product type. The manufacturers of the products identified for use in the Tailgate Test Kit were contacted to further discuss residual testing of their products.

2.6.2.1 Residual Testing of Product SCI-CW-A0

The manufacturer of product SCI-CW-A0 indicated that a laboratory test could be performed to test unreacted residual product. This test cannot be completed in the field and is a polymonomer acrilimide LC/MS test.

The manufacturer also recommended a couple observations/field level tests that could indicate an overdose with residual/unreacted product. These non-quantitative observations/field level tests include:

- After agitation of the test sample and/or the treated surface water look for a cloudy gray/white appearance. If gray/white appearance is present, the water has been overdosed.
- After settlement of floc particles, pour water over fingers and rub them together. If water feels slippery, you have residual product over the recommended dosage.

2.6.2.2 Residual Testing of Product FLOC-06

Based on conversations with the manufacturer of Floc 06, it is understood that the Floc 06 product is insoluble. As a result, residual floc 06 product is in a particulate form. A laboratory test for total suspended solids (TSS) could be performed to test for residual product, however, it may be difficult to distinguish residual Floc 06 Product from other particulates showing up as TSS.

The manufacturer also recommended a field level observation test that could indicate an overdose with residual/unreacted product. The observation is simply to check visually if there is residual/unreacted Floc 06 since the Floc product swells and creates a visible solid that is insoluble.

2.6.2.3 Residual Testing of Liquifloc 1% and Other Chitosan Based Products

Based on conversations with the manufacturer of the Liquifloc 1% product, there is a test that is available for purchase that can test chitosan based products in the field. This test is capable of testing the residual of chitosan based products down to 0.1 ppm. This residual test kit was not tested in developing the Tailgate Test Kit.

2.6.3 Maximum Product Dosing Limit Method

A single residual test that would work for all products, and product types, may not be feasible. Additionally, it may not be desirable to have several different product specific tests. An alternative method to testing residual would be to establish maximum dosing limits for each approved product. For this approach, there may be the possibility of some residual/unreacted product during application. The state of Wisconsin uses maximum dosing limits as the method for regulating product application (WDNR 2015).

2.6.4 Environmental stress Indication Test

Another possible alternative approach to testing residual could be performing an environmental stress indication test. The environmental stress indication test could monitor an environmental sensitivity indicator such as a minnow in the product treated sample for a predetermined time. The result of the test could indicate the potential environmental impact.

2.7 SAFETY, STORAGE, HANDLING, AND SPILL MANAGEMENT

Prior to using one of the products included in this study, or a new product, the manufacturers product Material Safety Data Sheet (MSDS) should be reviewed for proper safety, storage, handling, and spill management.

The manufacturer safety recommendations should be followed while using the products. In general, for the products tested in this study, safety recommendations for all handling applications includes minimum level D Personal Protective Equipment (PPE) which includes:

- Long pants,
- A shirt with sleeves,
- Safety glasses, and
- Closed toe work boots.

Proper hygiene procedures should also be followed while handling the products such as washing hands after handling the chemicals. In addition, do not eat, drink, smoke or apply cosmetics until hands have been washed and do not ingest any of the products. To assist with the handling recommendations, water, soap and towels should be available while handling the products. Additional details on product hazards, safety and emergency information for each product based on a review of product MSDS and manufacturer's recommendations are included in Appendix A.

The manufacturer recommendations for storage, handling and spill management should be followed for each product. In general, products included in this study should be stored in a dry, cool, and well ventilated location. Cleanup of spills for the products included in this study varies but can include vacuuming, sweeping/dry wiping, or soaking up/absorbing product. Do not flush with water or wet spilled products and wear proper PPE. Disposal of spilled product should be to a licensed landfill according to federal, state, and local regulations. Additional details on product storage procedures, spill

procedures, and waste considerations for each product based on review of product MSDS and manufacturer's recommendations are included in Appendix A.

CHAPTER 3: RESULTS

This section summarizes the results obtained from performing the product tests on the samples. Appendix G includes the detailed results and Appendix H includes the completed field worksheets that were used to record the raw data.

3.1 TEST PERFORMANCE SUMMARY

Table 3.1 summarizes the test results that achieved the target turbidity goal of 50 NTU for each sample. After Sample 4 was tested, the test results for each sample were reviewed and based on the results a shortened test list was identified.

Table 3.1 Test Results that Achieved Target Turbidity Goal of 50 NTU.

Test	Test Sample	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
1 (Control)	NA	NA	NA	NA	NA	NA	NA	NA
2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	No	No	Yes	Yes	No
4	Yes	No	No	No	No	-	-	-
5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	Yes	Yes	Yes	No	No	-	-	-
7	Yes	Yes	Yes	No	Yes	Yes	Yes	No
8	Yes	Yes	No	No	Yes	-	-	-
9	Yes	Yes	Yes	No	Yes	-	-	-
10	Yes	Yes	Yes	Yes	Yes	-	-	-
11	Yes	No	No	No	No	-	-	-
12	Yes	No	No	No	No	-	-	-
13	Yes	No	No	No	No	-	-	-

NA, Not Applicable
– Test not completed for that sample.

Due to the test results, Tests 4, 11, 12, 13 were not included in the shortened test list for the Tailgate Test Kit.

The test results for Test 6 were similar to Test 5, so Test 6 was not included in the shortened test list for use with the Tailgate Test Kit. If Test 5 meets the target turbidity goal, and the product is selected for full scale application, the Test 6 product combination may also be a potential option.

The test results for Tests 8, 9 and 10 were similar to Test 7, so Tests 8, 9, and 10 were not included in the shortened test list for use with the Tailgate Test Kit. If Test 7 meets the target turbidity goal, and the product is selected for full scale application, the Tests 8, 9, and 10 product combinations may also be a potential option.

3.2 RESULTS SUMMARY

The final treated sample was filtered through a coffee filter to measure the benefit of filtering. The results show that there is an additional reduction benefit due to filtering. Up to 82% removal was measured comparing the final unfiltered turbidity to the final filtered turbidity.

The initial pH was measured for each sample and the final pH was measured for each test. In general, only minor changes in pH (<±1.0) were observed from the initial to final measurements for 10 of the product tests. Notable changes in pH (>±1.0) were observed multiple times for Test 2 (Floc 06) and once for Test 6 (LB2101 (first) then Liquifloc 1% (second)).

For a couple of the samples, a final turbidity measurement was taken after all tests were completed to check how additional settling time affected the turbidity reduction. The results showed that additional reduction benefit was measured after additional settling time. This was specifically observed for Test 2 (Floc 06), Test 5 (Liquifloc 1%), Test 7 (Biostar-CH 2%).

3.3 VISUAL OBSERVATIONS

The following observations were made when performing the tests.

- For many of the tests, several doses were required before a reaction was noticed and/or measurable.
- After a reaction was noticed, the turbidity measured was dependent on the time allowed for settling of floc particles.
- The floc that formed varied for each product. The different products created either large floc, medium floc, or small floc.
- Significant amount of floating floc was observed multiple times with Test 2 (Floc 06). Based on conversations with the manufacturer, this is due to hydrocarbons, pigments, or dyes present in the sample. Filtration is recommended in removing floc particles in full scale applications that may be floating or suspended.
- The product for Test 4 (Earth Poly Stable Plus) would develop a thick/syrupy texture after product dosing.

CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

The overall objectives of this study were met.

- A Tailgate Test Kit was developed for field testing flocculants for reducing turbidity in construction stormwater discharge. Essential items for the test are:
  - A turbidity meter
  - Sample/test containers
  - Dose measurement tools
  - Field documentation worksheets (prepared as part of this study)
  - The products to be tested – four selected products include Floc 06, SCI-CW-A0, Liquifloc 1%, and Biostar-CH 2%
  - Personal protective equipment (PPE)
- Test procedures and dosing guidance are provided.
- Scaling procedures were developed to convert the test result into the dosing rate for full-scale product application.
- Methods for testing residual/unreacted product were investigated. No preferred method was identified for use. There does not appear to be a simple/straightforward residual test that can be included in the Tailgate Test Kit and used to test all floc products, or product types.

4.2 RECOMMENDATIONS FOR NEXT STEPS

Two recommendations are presented for next steps with this study.

First, it is recommended that the product list for the Tailgate Test Kit be periodically updated as necessary. Given time limitations, only selected products were tested in this study for the Tailgate Test Kit. It is expected that other effective products may be available and/or developed in the future.

Second, it is recommended to further investigate methods for identifying residual/unreacted products.

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1. Dreschel, S. J. (2014). Flocculation Treatment BMPs for Construction Water Discharges. Minnesota Department of Transportation Research Services and Library, St Paul, MN.

2. Wisconsin Department of Natural Resources, Bureaus of Water Quality and Watershed Management (2015). Water Quality Review Procedures For Additives. Guidance Number: 3400-2015-03, WisDOT, WI.

APPENDIX A

TASK 2: REVIEW PREVIOUS RESEARCH

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Dan Sullivan, Minnesota Department of Transportation

From: Kirby Templin and Jeff Strom, Wenck Associates, Inc.

Date: May 17, 2016

Subject: Task 2 – Review Previous Research

1. Introduction

The purpose of this technical memo is to identify the flocculants for use in the Tailgate Test Study, associated dosing guidance and mixing procedures, and to document the review of previous research on the use of flocculants to treat construction stormwater done by other state departments of transportation.

2. Select Flocculants for Use in Tailgate Test Study

The flocculants identified for potential use in the Tailgate Test Study are detailed in Table 1. The flocculants were identified based on input from the Minnesota Department of Transportation (MNDOT) and Technical Advisory Panel (TAP), review of Dreschel 2014, and review of other state Department of Transportation (DOTs). The flocculants identified for use in the Tailgate Test Study should provide results for a variety of soil types and adequately test and develop the "Tailgate Test" for testing flocculants on construction stormwater discharge in the field. It is recommended that additional flocculants, not listed above, be included or substituted into the tailgate test in the future as they are identified as preferred or effective flocculants for use with Minnesota soil types. Manufacturer's recommendations should be reviewed and followed for each flocculant for proper use, handling, storage and safety.

Table 1. Products Identified for use in the Tailgate Test Study.

Product Name	Manufacturer
Earth Poly-Stable Plus	Earth and Road
FLOC 06	Innovative Turf Solutions
SCI CW-A0	Standard Contracting
Biostar-CH	Hild and Associates
APL Bridger Flocculant	Hild and Associates
APS 703d#3 Floc Log	Applied Polymer Systems, Inc.

Product Name	Manufacturer
APS 706b Floc Log	Applied Polymer Systems, Inc.
LBP 2101 Coagulant	Dober
Liquifloc 1% Flocculant	Dober

3. Web Search

A web search was conducted to investigate how flocculants are used to treat construction stormwater in other states. The web search identified and included the following state environmental agencies and DOTs: Alabama, Georgia, Mississippi, New York, North Carolina, Oregon, Washington and Wisconsin. Table 2 provides a brief summary of the information available on each state's website. Additional information is available at the website links provided in Attachment A. In general, each state supports the use of approved flocculants as a potential BMP to treat stormwater runoff from construction sites. The review identified many potential flocculants for use, however, there was no definitive research or programs identified that would suggest the inclusion of flocculants identified by the web search in the Tailgate Test Study at this time. A table is included in Attachment B which lists the products approved for use by other DOTs that were identified through the web search. Most of the states include general language within their stormwater BMP manuals limiting the use of flocculants to certain applications and procedures. Most states review flocs on a case by case basis and some common themes for approved flocculants included:

- Cationic polymers are generally not supported due to toxicity concerns.
- Anionic polymer mixtures shall have less than or equal to 0.05% free acrylamide by weight as established by the FDA.
- Flocculants, especially polymers, shall not be directly applied to surface waters of the state.
- Flocculants should only be used when self-contained sediment control structures are in place downstream to settle the floc prior to discharge to surface waters.
- Applicators must provide Material Safety Data Sheets (MSDS) and toxicity information (supplied by the manufacturer) to the local permitting authority for approval prior to application in the field.
- Applicators should follow the manufacturer's recommended application rate and instructions.
- Flocculants shall be selected based on site-specific soil conditions through jar tests and/or other screening process.

A good example of guidance/procedures is Wisconsin DNR's Draft Technical Standard 1051 (Wisconsin DNR, 2015). Links to other state department websites with information on the use of flocculation are listed in the references section at the end of this memo.

Table 2. General findings from the DOT web search.

State	Findings
Alabama	DOT has list of approved Temporary Erosion and Sediment Control Products. The product list includes 8 flocculants and approved manufacturers.
Georgia	Erosion and Sediment Control Manual identifies flocculants as a potential BMP within construction storm water ditches and storm drainages which feed into pre-constructed ponds or basins. The state does not have an approved list of products or manufacturers. Application shall comply with all federal and local rules and regulations and the operator is responsible for securing applicable permits.
Mississippi	Mississippi DEQ's Erosion and Sediment Control Manual identifies flocculants as a potential practice in conjunction with pumped construction site stormwater systems. The manual contains jar test guidelines to determine the most effective type of PAM for a given site. The state does not have an approved list of products or manufacturers.
New York	Very little information/guidance available online regarding flocculants as a potential stormwater treatment practice
North Carolina	North Carolina Erosion and Sediment Control Practice Standards and Specifications Guidelines approves the use of flocculants as a potential BMP after all physical BMPs have been implemented. Only products that pass the state's chronic toxicity testing requirements are allowed. North Carolina Division of Water Resources maintains a list of approved PAMS/Flocculants.
Oregon	BMP handbook mentions the use of flocculants as possible BMP in stormwater runoff. However, the state does not have a well-developed set of guidelines, standards, or list of approved products. The state has conducted a fair amount of research on the effectiveness and environmental impacts of Chitosan products.
Washington	State Construction Stormwater Pollution Prevention Guidelines contains criteria for chemical treatment product use and treatment system design considerations for flocculants. The Washington Department of Ecology maintains an approved list of existing technologies and manufacturers.
Wisconsin	Wisconsin DNR recently released procedures/guidance (currently in draft form) for using additives for stormwater sediment control (Wisconsin DNR, 2015). This document defines toxicity, application and product approval criteria for polymers and other flocculants. The state does not have an approved list of products or manufacturers.

4. Dosage Guidance

The dosage guidance for the flocculants identified for use in the Tailgate Test Study are based on manufacturer's recommendations, unless noted otherwise, and are detailed in Table 3. Flocculant dosing should follow manufacturer's recommendations. Many of the flocculants identified can be obtained in a dry powder or liquid form, and in different concentrations. The flocculants received from the vendor are either a dry powder, a liquid solution ready for use in the study, or a high concentration formulation from which a reduced concentration solution needs to be created. The formulations obtained for use in the Tailgate Test Study were primarily a dry powder or liquid solution ready for test application. Although other formulations and concentrations are available for many of the products tested, the formulation used in the study was identified as the easiest formulation for use at a bench scale test level.

Dosage guidance is dependent on engineering factors which include but are not limited to flow rate and the flocculant solution concentration. The overall effectiveness of a flocculant is dependent on several environmental factors which include but are not limited to construction stormwater discharge turbidity, pH, and temperature. Based on the literature review of the products and discussions with manufacturers, there are no untreatable

turbidity limits, however thick sludge or mud consistencies are not treatable. In general, as turbidity increases, a higher dosage is required. Based on discussions with manufacturers, temperature appears to not inhibit a reaction as long as the stormwater is a liquid (not frozen). However, lower temperatures may cause the reaction time to slow down or require an increase in dosing for the reaction to occur. The ranges of environmental factors that influence effectiveness of the flocculants are detailed in Table 3.

Table 3. Dosage Guidance Identified for Specific Flocculants.

Product Name	Tailgate Test Formulation	Dosage Guidance	Environmental Factors
Earth Poly-Stable Plus	Dry Powder	For soil stabilization, 20lbs per acre dry mix, or mix 1-lb per 100 gallons for hydro seeding application. (no guidance documentation identified)	**pH Range,** Around Neutral **Temperature Range,** historically has not been an issue **Shelf Life,** 2 years
FLOC 06	Dry Powder	A 1-lb per 1,000 gallons construction stormwater discharge ratio is the dosage guidance (~120 mg per 1000 ml). For Tailgate test, add small quantity "pinch" if no reaction observed add more until desired results are achieved. (no guidance documentation identified)	**pH Range,** 4 to 12 **Temperature Range,** No **Shelf Life,** 2+ years
SCI CW-A0	Dry Powder	For Tailgate test, add small quantity using smidgen measurement (Start with half smidgen, if no reaction add the other half smidgen). Approximately 0.25g/1L. (no guidance documentation identified)	**pH Range,** historically has not been an issue **Temperature Range,** No **Shelf Life,** 8 to 16 months
Biostar-CH And APL Bridger Flocculant	Liquid Solution	For turbidity of 200 to 400 NTU dosage of 1 mg/L, 400 to 600 NTU dosage of 2 mg/L, 600 to 800 NTU dosage of 3 mg/L, 800+ NTU dosage of 4 mg/L (Based on a 2% Solution). (guidance tables and charts identified)	**pH Range,** 6 to 9 **Temperature Range,** Lower temperatures require a higher dosage **Shelf Life,** 12 to 24 months
APS 703d#3 Floc Log And APS 706b Floc Log	Floc Log	Single Product testing: Add about ½ of a pencil eraser sized piece of Floc Log sample to the sample water. Duplex Product testing Simultaneously: Add about ½ of a pencil eraser sized piece of two different Floc Log samples to the sample water. Duplex Product testing separately: Add about ½ of a pencil eraser sized piece of 703d#3 Floc Log sample to the sample water. Remove first Floc Log sample (703d#3) and add second Floc Log sample (706b). (guidance documents identified)	**pH Range,** above 3 **Temperature Range,** Reaction takes longer at lower temperatures (40 degrees or less) **Shelf Life,** Up to 5 Years
LBP 2101 Coagulant And Liquifloc 1% Flocculant	Liquid Solution	Dosage guidance for two part mix with LB2101 and Liquifloc 1%. Dosage ratios for # of drops LBP 2101/Liquifloc 1% (1/1, 2/1, 2/2, 3/2, 3/3, etc). Try 1/1 first, if no reaction add next ratio in addition, continue until desired results. Liquifloc 1% can be used by itself. Slow mix method and add additional drops until desired results. (no guidance documents identified)	**pH Range,** 6.5-8.5 **Temperature Range,** No **Shelf Life,** 2+ years

5. Best Mixing Procedures

The mixing procedures for the flocculants identified for use in the Tailgate Test Study are based on manufacturer's recommendations, unless noted otherwise, and are detailed in Table 4. Flocculant application and mixing procedures should follow manufacturer's recommendations. The flocculants require different mixing procedures but in general are either rapid mixing or slow mixing. Rapid mixing can be achieved by shaking the sample by hand after application of the flocculant. Slow mixing can be achieved by stirring the sample slowly while the flocculant is applied.

The goal of the Tailgate Test kit is to quickly test several flocculants to identify effective flocculants that work for the project site. When transitioning to large scale application, it is important to deliver/apply the flocculant to the construction stormwater discharge in a manner that is similar to the mixing procedure used in the Tailgate Test to achieve similar results. Similarly, the mixing procedure used in the Tailgate Test should mimic the mixing procedure that is planned for large scale application. After the Tailgate Test, it is recommended that a larger scale test application is performed to measure the effectiveness of scaling the dosing rate and mixing procedure. Adjustments to the dosing rate and mixing procedure should be made as necessary to achieve desired results.

Table 4. Mixing Procedures Identified for Specific Flocculants.

Product Name	Mixing Method	Mixing Procedures
Earth Poly-Stable Plus	Rapid Mixing	Product can be applied in dry powder form and mixed rapidly by hand shaking. Flocculation is expected to occur quickly, within 1 minute. For large scale application, can be applied as dry powder to surface or can be applied by hydroseeding method to surface.
FLOC 06	Rapid Mixing	Product can be applied in dry powder form and mixed rapidly by hand shaking. Flocculation is expected to occur almost instantly. For large scale application, can be applied by hand or spreader directly onto/into BMPs.
SCI CW-A0	Rapid Mixing	Product can be applied in dry powder form and mixed rapidly by hand shaking. Flocculation is expected to occur within 30-40 seconds. Bench level testing should imitate the mixing method/BMP used for large scale application.
Biostar-CH And APL Bridger Flocculant	Slow Mixing	Vigorously stir the drops into the solution (Do not shake). The reaction is instantaneous (less than 10 seconds). Allow 5 minutes for settling to occur. Settling and/or filtration is needed for removal of the floc which For large scale application settling in basin may take 12 to 24 hours. The Biostar-CH and APL Bridger Flocculant can be used both independently and in coordination with each other. Effective treatment depends on site specific conditions. Test both separately, also test Biostar-CH first then APL Bridger second, and lastly test APL Bridger first then Biostar-CH second.
APS 703d#3 Floc Log And APS 706b Floc Log	Slow Mixing	Single Product testing: Moderately swirl the container to mix the sample with the product. The reaction should happen within 1 minute. Duplex Product testing Simultaneously: Moderately swirl the container to mix the sample with the product. The reaction should happen within 1 minute. Duplex Product testing separately: Moderately swirl the container after addition of the first 703d#3 Floc Log sample to mix the sample with the product until destabilization begins (record time). After removing 703d#3 and adding 706b moderately swirl until water is clear. The reaction should happen within 1 minute.

Product Name	Mixing Method	Mixing Procedures
LBP 2101 Coagulant And Liquifloc 1% Flocculant	Rapid Mix LBP 2101 And Slow Mix Liquifloc 1%	Mixing guidance for DPS (Dual Part System) mix with LB2101 and Liquifloc 1%. Add LBP 2101 first (Rapid Mix) then add Liquifloc 1% second (Slow Mix). See dosage guidance for more mixing details. Liquifloc 1% can be used by itself. Slow mix method and add additional drops until desired results.

6. Best Management Practices

The flocculants presented in this memo can be used in a variety of ways for reducing total suspended solids (TSS) in construction stormwater discharge. Many of the products may be applied directly to disturbed bare soil to bind sediments and reduce erosion resulting in overall lower TSS in the construction stormwater. The products can also be applied directly to high TSS concentration construction stormwater through many delivery and application methods prior to discharging offsite.

There are several delivery and application methods that have been tested with success. The effectiveness of each delivery method is the result of the mixing associated with the delivery/application. It is important to test and mix the flocculants in the tailgate test similarly to the mixing that is anticipated during large scale delivery and application. Some of the delivery and application methods include: directly applying to the surface of a storage BMP (mixing mechanism may be required), direct injection to surface flow and/or pipe flow, and passive dosing with a floc filled bag installed instream, within a conveyance system or at a concentrated discharge point (inlet). See links in Attachment A to diagrams/pictures of dosing methods/examples.

Manufacturers offer their flocculant products in several formulations which allow for multiple delivery and application options. A summary of formulations available from the manufacturers of the flocculants used in this study is included in Table 5.

After effective flocculants are identified from the tailgate test for use in a large scale application, it is recommended that the manufacturer is contacted to discuss the site conditions, environmental factors, and project goals to get feedback and recommendations from the manufacturer.

Table 5. Formulations Available by Manufacturer.

Manufacturer	Formulations Available From Manufacturer
Earth and Road	The product is primarily available in liquid solution for application. The product can also be used in an open weave monofilament geotextile to be placed in an active flow.
Innovative Turf Solutions	The product is a dry powder. The product can also come in a sock and bag form for different application methods. There are 25-30 different blend options to target specific contaminants.
Standard Contracting	Product is only available in a dry powder form.

Manufacturer	Formulations Available From Manufacturer
Hild and Associates	Biostar CH Acetate Liquid solution available in concentrations of 1% and 2%. Biostar Bridger liquid available in 0.5% concentration. Biostar CH Lactate Flake is a solid form of the product that is available in a treatment bag application.
Applied Polymer Systems, Inc.	For water clarification, the floc log products are used. Other products for erosion control and other applications are available in powders or emulsions.
Dober	The Liquifloc and LB2101 DPS (Dual Part System) is available in a liquid form or solid/flake form. The liquid form is available in multiple concentrations.

7. Safety, Storage, Handling and Spill Management

Manufacturer recommendations for safety should be followed while using the products. Safety for all handling applications includes minimum level D Personal Protective Equipment (PPE) which includes: long pants, a shirt with sleeves, safety glasses, and closed toe work boots. Proper hygiene procedures should be followed such as washing hands after handling the chemicals. Do not eat, drink, smoke or apply cosmetics until hands are washed. Water, soap and towels should be available while handling chemicals. Do not ingest any of the products. Table 6 summarizes product hazards, safety and emergency information for each product based on review of manufacturer's recommendations.

Table 6. Summary of Product Hazard, Safety, and Emergency Information.

Product Name	Physical State	Health Hazards	Physical Hazards	Recommended PPE and Practices	Emergency Procedures
Earth Poly-Stable Plus	Solid white powder	**Eyes** – Irritation **Skin** – Irritation **Inhalation** – Irritation **Ingestion** – Weakness, headache **Toxicity** – None expected. Ingestion of large amounts may cause serious health effects.	Slippery when wet. Slightly flammable.	Safety glasses, nitrile gloves, washing facilities.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
FLOC 06	Solid/powder	**Eyes** – Irritation **Skin** – Irritation **Inhalation** – Contains silica, respiratory hazard - carcinogen **Ingestion** – Irritation **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities. Avoid exposure to dust. Respiratory protection recommended if dust is generated.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
SCI CW-A0	Solid/powder	**Eyes** – Irritation **Skin** – Irritation **Inhalation** – Contains silica, respiratory hazard – carcinogen. **Ingestion** – None expected **Toxicity** – None expected	Slippery when wet.	Safety glasses, nitrile gloves, washing facilities. Avoid exposure to dust. Respiratory protection recommended if	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.

Product Name	Physical State	Health Hazards	Physical Hazards	Recommended PPE and Practices	Emergency Procedures
				dust is generated.	
Biostar-CH	Liquid	**Eyes** – Irritation **Skin** – None expected **Inhalation** – None expected **Ingestion** – None expected **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
APL Bridger Flocculant	Powder or liquid	**Eyes** – Irritation **Skin** – Irritation **Inhalation** – Irritation **Ingestion** – Nausea, vomiting, diarrhea **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
APS 703d#3 Floc Log	Blue semi solid gel	**Eyes** – Irritation **Skin** – Irritation, drying **Inhalation** – None expected **Ingestion** – None expected **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
APS 706b Floc Log	Blue semi solid gel	**Eyes** – Irritation **Skin** – Irritation, drying **Inhalation** – None expected **Ingestion** – None expected **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
LBP 2101 Coagulant	Liquid	**Eyes** – Irritation **Skin** – Irritation **Inhalation** – Irritation **Ingestion** – Irritation **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.
Liquifloc 1% Flocculant	Liquid	**Eyes** – Irritation **Skin** – Irritation **Inhalation** – Irritation **Ingestion** – Irritation **Toxicity** – None expected	None expected	Safety glasses, nitrile gloves, washing facilities.	If material contacts skin or eyes, flush with water. Seek medical attention if victim feels unwell after inhalation or ingestion.

Manufacturer recommendations for storage, handling and spill management should be followed. Table 7 summarizes general product storage procedures, spill procedures, and waste considerations for each product based on review of manufacturers recommendations.

Table 7. Summary of Product Storage, Handling and Spill Management Procedures.

Product Name	Tailgate Test Formulation	Storage Guidance	Spill Procedures and Waste Considerations
Earth Poly-Stable Plus	Dry Powder	Store in a dry, cool and well ventilated location.	No special precautions required. Sweep up and scoop into suitable container for use or recycle. Do not flush with water, rather scoop or vacuum and then flush remaining traces with water. Spread the recovered contents on land, or, if contaminated dispose in a properly designated landfill.
FLOC 06	Dry Powder	Store in a dry, cool and well ventilated location.	Avoid breathing dust, wear respirator approved for silica dust. Vacuum up spilled material to avoid generating airborne dust. Avoid using water as product will become slippery when wetted. Dispose of waste in a licensed landfill according to federal, state and local regulations.
SCI CW-A0	Dry Powder	Store in a dry, cool and well ventilated location.	Avoid breathing dust, wear respirator approved for quartz, cristobalite and tridymite dust. Vacuum up spilled material to avoid generating airborne dust. Avoid using water as product will become slippery when wetted. Dispose of waste in a licensed landfill according to federal, state and local regulations.
Biostar-CH And APL Bridger Flocculant	Liquid Solution	Store between 50-122 degrees F, solution will freeze at 26 degrees F (-3 C).	For spills, absorb with acid absorbent to recover the free product, then clean residue with soap and water. Landfill disposal of collected waste is acceptable as the compound is biodegradable. Dispose of waste in a licensed landfill according to federal, state and local regulations.
APS 703d#3 Floc Log And APS 706b Floc Log	Floc Log	Store in a dry, cool and well ventilated location.	Dry wipe spilled material as well as possible and place collected material in a suitable and closed container. Flush remaining traces with water. Dispose of waste in a licensed landfill according to federal, state and local regulations.
LBP 2101 Coagulant And Liquifloc 1% Flocculant	Liquid Solution	Store in the original container in a dry, cool and well-ventilated place. Keep container closed when not in use.	For spills, soak up materials with inert solids, such as clay or diatomaceous earth as soon as possible. Store away from other materials. Dispose of waste in a licensed landfill according to federal, state and local regulations.

8. References

Dreschel, S. J. (2014). Flocculation Treatment BMPs for Construction Water Discharges. Minnesota Department of Transportation Research Services and Library. St Paul, MN.

Wisconsin DNR (2015). Technical Standard 1051 (DRAFT). "Water Application of Additives for Sediment Control".
http://dnr.wi.gov/news/input/documents/guidance/TS1051Guidance.pdf

Attachment A

Website Links for Reference

Links to State Information

Alabama:

http://swcc.alabama.gov/pdf/Erosion%20Handbooks&Guides/Complete_Field_Guide.pdf

http://swcc.alabama.gov/pdf/Erosion%20Handbooks&Guides/2014%20Handbook%20Complete%20Volume/2014%20ESC%20Handbook%20Vol%201.pdf

http://www.dot.state.al.us/mtweb/Testing/MSDSAR/QMSD_index.htm

http://www.dot.state.al.us/mtweb/Testing/MSDSAR/doc/QMSD/Lii24.pdf

Georgia:

https://gaswcc.georgia.gov/sites/gaswcc.georgia.gov/files/Manual_for_Erosion_and_Sediment_Control_in_Georgia_Sixth_Edition_2014.pdf

Mississippi:

https://deq.state.ms.us/mdeq.nsf/page/NPS_PlanningandDesignManual2ndEd_Vol1?OpenDocument

http://opcgis.deq.state.ms.us/Erosion_Stormwater_Manual_2ndEd/Volume1/Chap_4_Sections/4_6/V1_Chap4_6_Sediment_Control_FLC.pdf

North Carolina:

http://www.hendersoncountync.org/engineering/erosion/Manuals/Chapter_206_March_2009.pdf

http://portal.ncdenr.org/c/document_library/get_file?uuid=3c3b8bb4-3f8b-406c-b4c7-4bdf3f7d91f1&groupId=38364

http://portal.ncdenr.org/c/document_library/get_file?uuid=bce262fc-256f-438e-9208-57bc3102929f&groupId=38364

Oregon:

http://www.deq.state.or.us/wq/stormwater/docs/nwr/flocculation.pdf

http://www.oregon.gov/ODOT/TD/TP_RES/docs/reports/assessingtheeffectandenvir.pdf

http://www.oregon.gov/ODOT/TD/TP_RES/research_notes/rsn06-07.pdf

Washington:

http://www.wsdot.wa.gov/research/reports/fullreports/490.1.pdf

http://www.ecy.wa.gov/programs/wq/stormwater/wwstormwatermanual/final_bmp_c250_12_06.pdf

http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

Wisconsin:

http://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/environment/Stormwtr-mgmnt.aspx

http://dnr.wi.gov/news/input/documents/guidance/TS1051Guidance.pdf

http://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/pal/default.aspx

Links to Diagrams/Pictures of Dosing Methods/Examples

Mississippi DEQ has diagram of sample pumped flocculation injection system and a picture showing example of PAM treated channel using inlet protection fabric on page 4-330 at the following link:

http://opcgis.deq.state.ms.us/Erosion_Stormwater_Manual_2ndEd/Volume1/Chap_4_Sections/4_6/V1_Chap4_6_Sediment_Control_FLC.pdf

The report at the following link contains several diagrams and examples of flocculation systems and water storage and settling tanks (see pages 32-37):

http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(74)_FR.pdf

The EPA handout document at the following link contains several examples of polymer flocculation BMPs (see pages 2-7):

http://www.siltstop.com/pictures/US%20EPA%20Polymer%20Flocculant%20Handout,%203-14.pdf

The technical report document by the US DOT at the following link has several example schematics of chemical treatment/dosing systems (see pages 17-22):

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwjFxqv9gofMAhVI-2MKHdDlDGAQFggkMAI&url=http%3A%2F%2Fwww.ctiponline.org%2Fpublications%2Fview_file.ashx%3FfileID%3D250&usg=AFQjCNFDxd9odONRe6yCv5JV7MYWCNVcZA

Attachment B

Matrix of Other Department of Transportation Approved Flocculants

State	Manufacturer	Product Name	Notes
Alabama	Applied Polymer Systems	APS 700 Series	State Identification Code PEB# 1264
	Innovative Turf Solutions	EnviroPam (Granular)	State Identification Code PEB# 1232
	Innovative Turf Solutions	FLOC	State Identification Code PEB# 2907
	HaloSource, Inc.	HaloKlear/StormKlear DBP-2100 & Gel Floc (System)	State Identification Code PEB# 4018
North Carolina	Applied Polymer System	APS 712	Maximum Recommended Concentration: 59.3 ppm
		APS 730	Maximum Recommended Concentration: 5.6 ppm
		APS 740	Maximum Recommended Concentration: 5.2 ppm
		APS 703d	
		APS 703d#3	
		APS 706b	
		APS 705	Maximum Recommended Concentration: 27.7 ppm
	Aquamark, Inc	AQ100	Land surface application only at 39.7 ppm
		AQ109	Land surface application only at 0.180g/l
	Ashland Hercules Water Tech	Ashland Charge Pac 55	Maximum Recommended Concentration: 10 mg/L
		Ashland Zalta MC 9500	Maximum Recommended Concentration: 10 mg/L
	Cape Fear Consulting	PAX-CFC39A	Maximum Recommended Concentration: 5 ppm
		CFC-4330	Maximum Recommended Concentration: 4.5 ppm
	Carolina Hydrologics	HYDROLOC PAM	Land surface application only at 3.0 mg/l
	Chemical Solutions, Inc.	CS-1234 and/or CS-1234D	Maximum Recommended Concentration: 500 mg/L per

State	Manufacturer	Product Name	Notes
			18% solids
		MK7154DP	Maximum Recommended Concentration: 10 mg/L
	Green Techniques	Soil Defender	Land surface application only at 0.008%
	HaloSource, Inc.	GelFloc	Maximum Recommended Concentration: 2.56 mg/L
		LBP-2101	Maximum Recommended Concentration: 500 mg/L
	Hanes Geo Components	TerraGuard Granular PAM	Maximum Recommended Concentration: 3.25mg/L
	Innovative Turf Solutions	EnviroPam	Maximum Recommended Concentration: 200 mg/L
		Erosion Guard Powder, Erosion Guard Logs/Erosion Guard Flats	Maximum Recommended Concentration: 200 mg/L
		FLOC	Maximum Recommended Concentration: 650 mg/L
	Leaner Meaner Greener, Inc	L.M.G. Dust Magnet 281 Solution	Maximum Recommended Concentration: 0.05%
		L.M.G. Dust Magnet 163 powder	Maximum Recommended Concentration: 0.5 mg/L
		DBP-2100	Maximum Recommended Concentration: 28.125 mg/L
	Nalco	Nalco 8187	Maximum Recommended Concentration: 100 ppm
	NTU	GeoScrub 10, 13, 20, 23, 34	Maximum Recommended Concentration: 10 mg/L
		GeoScrub Bubbles	Maximum Recommended Concentration: 1 mg/L
	Paschal Associates Sales	PFR P251	Maximum Recommended Concentration: 25 ppm
	Southeastern Laboratories	SEL FLOC 6026	Maximum Recommended Concentration: 7.5 ppm
	Storm Klear	3% Liqui-Floc	Maximum Recommended Concentration: 9.4 mg/L

State	Manufacturer	Product Name	Notes
	Terra Novo	EarthGuard	Maximum Recommended Concentration: .000625 mL/L
Washington	Pacific Inter-Mountain Distribution, LLC	EnviroTac II	Determined to be functionally equivalent to BMP C126 Polyacrylamide for Soil Erosion Protection and BMP C140 Dust Control.
	Innovative Turf Solutions	Floc	Determined to be functionally equivalent to Chitosan as a flocculent for use in BMP C250: Chemical Treatment
Wisconsin	Central Fiber Corp.	Hydroboost Tacpac GT	
	Profile Products	Con-Tack A/T	
	Eastern Products Inc.	Eco Tak-OP	
		Eco Tak-SAT	
	HydroStraw	Fiber RX	
	Innovative Turf Solutions	Hydra Tac	
	Mat Inc.	Mat-ST-SS	

APPENDIX B

TASK 3: TAILGATE TEST KIT DESCRIPTION

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin and Louis Sigtermans, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Task 3 –Tailgate Test Kit Description

The purpose of this technical memo is to summarize and describe the supplies that were used in the Tailgate Test Kit development for testing flocculants on construction stormwater discharge in the field. The supplies included in the Tailgate Test Kit study are detailed in Table 1, and shown in Photos 1 and 2. Items were selected based on portability, organization, and item durability for research and testing conditions. The list is intended as a guide to help identify what supplies to include and their intended purpose/use. Not all of the following items are necessary to put together a Tailgate Test Kit.

Table 1. Supplies included in the Tailgate Test Study.

Organizational Category	Item Description	Purpose/Intended Use	Quantity
Storage	45 gallon plastic tote	Storage of all test kit supplies	1
	Plastic storage containers	Organization of PPE, office/misc., products, measurement tools	As needed
	5 gallon buckets with lids	Bulk sample storage, rinse water storage	As needed
Documentation	Safety Data Sheets (SDS)	Flocculant product information (handling, safety, spill management)	Each product
	Field note worksheets	Recording results/notes	As needed
	Clipboard	Writing surface for worksheets	1
	3-ring binder with tab dividers	Contains SDS info, worksheets, etc.	1
Office	Permanent markers	Marking and labelling of samples, cuvettes, etc.	As needed
	Pens	Recording results/notes on worksheets	As needed
	Digital stopwatch/timers	Recording time between doses	2

Organizational Category	Item Description	Purpose/Intended Use	Quantity
Cleaning	Paper towels	Cleaning aid	As needed
	Coffee filters	Used to simulate filtering of flocculated stormwater discharge samples	As needed
	Plastic trash bags	Trash collection for disposable pipettes, paper towels, filters, PPE, etc.	As needed
	Ziplock bags	As needed for soil sample collection	As needed
Personal Protective Equipment (PPE)	N95 particulate filter respirators	Protection against powder flocculant inhalation hazard	As needed
	Disposable nitrile gloves	Protection against flocculant/sample skin exposure	As needed
	Safety glasses	Protection against flocculant/sample eye exposure	Each analyst
Sample Storage/Mixing	48 oz. clear wide mouth silo Nalgene bottles	Sample testing and mixing container, clear to allow for visual observation of floc, sufficiently tall to allow for settling	1 for each test/product
	Plastic paint stir sticks	Sample stirring for slow mix methods	As needed
	Plastic funnels	Holds coffee filters used for filtering flocculated samples, and transferring stormwater discharge samples between containers	3
Dosage Measurement	Funnel rack	Holds filter funnels above 5 gallon bucket	1
	Measuring spoon sets: tad, dash, pinch, smidgen, drop	Dry power flocculant dosage measurement	2 sets
	1 mL disposable plastic pipettes	Sample transfer into cuvettes for turbidity readings; liquid flocculant dosage measurement	2 bags of 100
Meters and Related Supplies	pH and temperature meter	Sample pH and temperature measurement; follow manufacturer procedures	1
	Turbidity meter with 1,000+ NTU reading capability	Sample turbidity measurement; follow manufacturer procedures	1
	Standard calibration solutions	As needed for turbidity and pH meter calibration	As needed
	Distilled water	Turbidity blank for calibration and equipment rinsing	As needed

Photo 1. Tailgate Test Equipment and Supplies

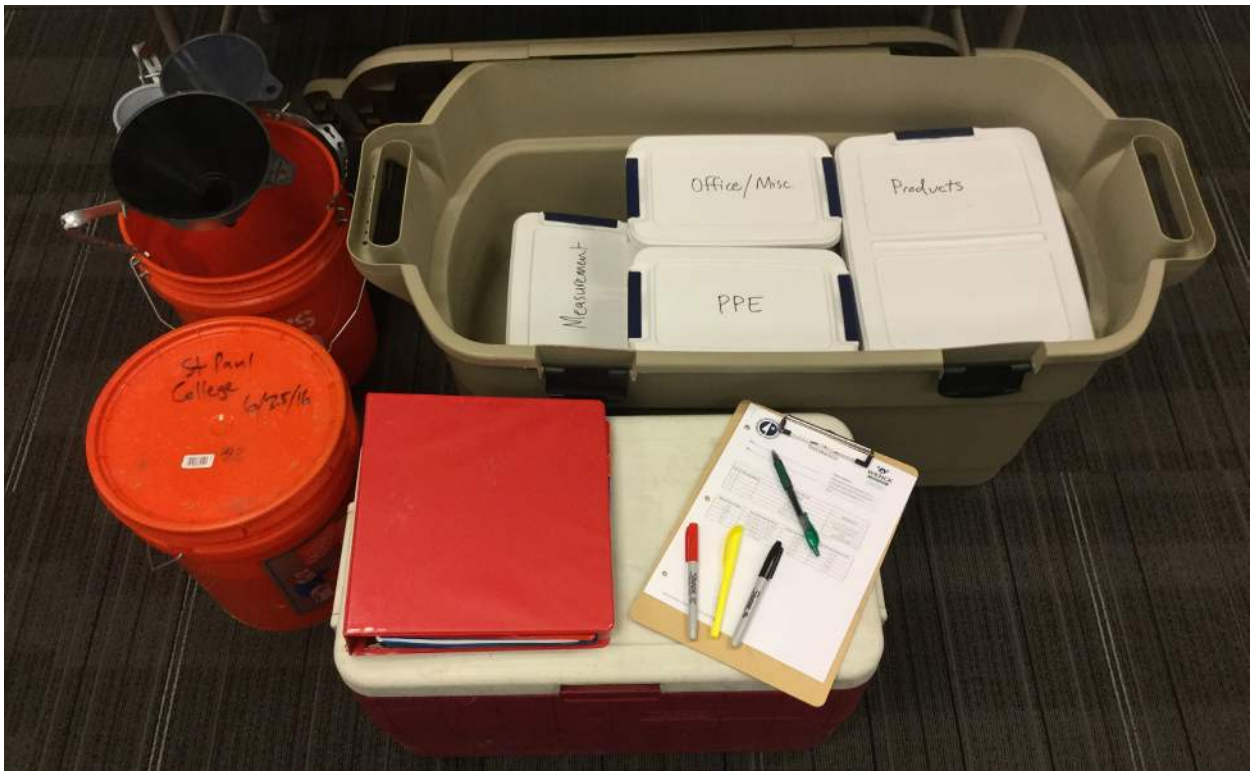


Photo 2. Tailgate Test Storage and Documentation Supplies

APPENDIX C

COMPLETE STUDY TEST WORKSHEETS

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin and Louis Sigtermans, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Test Protocol and Worksheets (Complete Study Product List)

Individual worksheets were developed for each product that was tested as part of the development of the Tailgate Test Kit. The worksheets were revised based on user feedback during testing and data collection for development of the Tailgate Test Kit. This memo includes the worksheets developed for the initial 13 tests are included in Attachment A. Not all of the 13 tests were recommended for use in the Tailgate Test Kit due to test results and observations.

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment A

Complete Study Test Worksheets

Complete Study Test Worksheets

Responsive partner. Exceptional outcomes.

Field Analyst(s):

Date: _____

Site: _____

Table 1 - Product Test List				
Test #	**Test Completed**	**Product Name**	**Manufacturer**	**Formulation**
1		Control	-	-
2		Floc 06	Innovative Turf Solutions	Dry Powder
3		SCI-CW-A0	Standard Contracting	Dry Powder
4		Earth Poly-Stable Plus	Earth and Road	Dry Powder
5		Liquifloc 1%	Dober	Liquid Solution
6		LB2101 (first) then Liquifloc 1% (second)	Dober	Liquid Solution
7		Biostar-CH 2%	Hild and Associates	Liquid Solution
8		APL Bridger	Hild and Associates	Liquid Solution
9		Biostar-CH (first) then APL Bridger (second)	Hild and Associates	Liquid Solution
10		APL Bridger (first) then Biostar-CH (second)	Hild and Associates	Liquid Solution
11		APS 703d#3 Floc Log	Applied Polymer Systems, Inc.	Floc Log
12		APS 706b Floc Log	Applied Polymer Systems, Inc.	Floc Log
13		APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.	Floc Log

Table 2 - Dry Product Measurement Conversions			
Measurement Spoon	**Equivalent Measurement**	**Volume Equivalent (fl oz)**	**Volume Equivalent (mL)**
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Table 3 - Product Weight Conversions				
Product Name[1]	**Measurement**	**Volume Equivalent (mL)**	**Weight Equivalent (g)**	**Density (g/mL)**
Floc 06	1 drop (spoon)	0.07701	0.06887	0.8942
SCI-CW-A0	1 drop (spoon)	0.07701	0.06435	0.8355
Liquifloc 1%	1 drop (pipette[2])	0.0475	0.04773	1.0048
Biostar-CH 2%	1 drop (pipette[2])	0.0469	0.04592	0.9790

[1] Density information was not measured for all products

[2] Pipette referred to is the 1 mL disposable pipette used in the research field tests

Test # 1

Responsive partner.
Exceptional outcomes.

Field Analyst(s):

Date: _____

Site: _____

Product Tested: Control

Mixing Method: No Mixing Method

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial					

Notes:

- The control is a reference that can be used to compare the results from the products that are tested.
- There are no products tested in the control.

Test # 2

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Floc 06 (Innovative Turf Solutions)

Test Volume: _____

Mixing Method: Rapid Mix (Shaking)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 3

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: SCI-CW-A0 (Standard Contracting)

Test Volume: _____

Mixing Method: Rapid Mix (Shaking)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 4

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Earth Poly-Stable Plus (Earth and Road)

Test Volume: _____

Mixing Method: Rapid Mix (Shaking)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 5

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Liquifloc 1% (Dober)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 6

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Dual Part System (DPS) LB2101 and Liquifloc 1% (Dober)

Test Volume: _____

Mixing Method: Rapid Mix - LB2101 (Shaking)
Slow Mix - Liquifloc 1% (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Start mixing ratio at step one which is to add 1 drop LB2101 and shake for 5 seconds and then add 1 drop Liquifloc 1% and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, perform next mixing step. If reaction is noticed, wait remainder of 5 minutes to test turbidity (Allows for settling). Repeat for next mixing step until desired results.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Start Time (clock): _____

Time (min)	Step	Pre-filter Turbidity (NTU)

Step Table:

Step	LB2101 Added (Drops)	Liquifloc 1% Added (Drops)	Cumulative Dosage (Drops)
1	1	1	1 / 1
2	2	1	3 / 2
3	2	2	5 / 4
4	3	2	8 / 6
5	3	3	11 / 9
6	4	3	15 / 12
7	4	4	19 / 16
8	5	4	24 / 20

Cumulative Dosage: LB2101 / Liquifloc 1%

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 7

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Biostar-CH 2% (Hild and Associates)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 8

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: APL Bridger (Hild and Associates)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 9

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Biostar-CH (first) then APL Bridger (second)
(Hild and Associates)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Product Code: A = APL Bridger, B = Biostar-CH 2%

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 10

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: APL Bridger (first) then Biostar-CH (second)
(Hild and Associates)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Start Time (clock): _____

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Product Code: A = APL Bridger, B = Biostar-CH 2%

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 11

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: APS 703d#3 Floc Log (Applied Polymer Systems, Inc.)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Mixing/Dosing Guidance:

Add 1/2 pencil eraser-sized piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5- and 10-minute times. Stir for 30 seconds after 10-minute time. Test turbidity at the 15- and 20-minute times. Stir for 30 seconds after 20-minute time. Test turbidity at the 25- and 30-minute times. Repeat as necessary.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Pre-filter Turbidity (NTU)
5	
10	
Stir for 30 seconds	
15	
20	
Stir for 30 seconds	
25	
30	

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 12

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: APS 706b Floc Log (Applied Polymer Systems, Inc.)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Mixing/Dosing Guidance:

Add 1/2 pencil eraser-sized piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5- and 10-minute times. Stir for 30 seconds after 10-minute time. Test turbidity at the 15- and 20-minute times. Stir for 30 seconds after 20-minute time. Test turbidity at the 25- and 30-minute times. Repeat as necessary.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Pre-filter Turbidity (NTU)
5	
10	
Stir for 30 seconds	
15	
20	
Stir for 30 seconds	
25	
30	

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 13

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: APS 703d#3 and APS 706b Floc Log (simultaneously)
(Applied Polymer Systems, Inc.)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Mixing/Dosing Guidance:

Add 1/2 pencil eraser-sized piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5- and 10-minute times. Stir for 30 seconds after 10-minute time. Test turbidity at the 15- and 20-minute times. Stir for 30 seconds after 20-minute time. Test turbidity at the 25- and 30-minute times. Repeat as necessary.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Pre-filter Turbidity (NTU)
5	
10	
Stir for 30 seconds	
15	
20	
Stir for 30 seconds	
25	
30	

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

APPENDIX D

TASK 4: TAILGATE TEST KIT WORKSHEETS

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin and Louis Sigtermans, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Task 4 –Tailgate Test Kit Worksheets

Individual worksheets were developed for each product that was tested as part of the development of the Tailgate Test Kit. The worksheets were revised based on user feedback during testing and data collection for development of the Tailgate Test Kit. Based on the study results and observations, a shortened list of product worksheets was identified for use with the Tailgate Test Kit. The worksheets for use with the Tailgate Test Kit are included in Attachment A.

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment A

Tailgate Test Kit Worksheets

Tailgate Test Kit

Test Worksheets

Responsive partner.
Exceptional outcomes.

Field Analyst(s):

Date: _____

Site: _____

Table 1 - Product Test List				
Test #	**Test Completed**	**Product Name**	**Manufacturer**	**Formulation**
1		Control	-	-
2		Floc 06	Innovative Turf Solutions	Dry Powder
3		SCI-CW-A0	Standard Contracting	Dry Powder
5		Liquifloc 1%	Dober	Liquid Solution
7		Biostar-CH 2%	Hild and Associates	Liquid Solution

Table 2 - Dry Product Measurement Conversions			
Measurement Spoon	**Equivalent Measurement**	**Volume Equivalent (fl oz)**	**Volume Equivalent (mL)**
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Table 3 - Product Weight Conversions				
Product Name	**Measurement**	**Volume Equivalent (mL)**	**Weight Equivalent (g)**	**Density (g/mL)**
Floc 06	1 drop (spoon)	0.07701	0.06887	0.8942
SCI-CW-A0	1 drop (spoon)	0.07701	0.06435	0.8355
Liquifloc 1%	1 drop (pipette[1])	0.0475	0.04773	1.0048
Biostar-CH 2%	1 drop (pipette[1])	0.0469	0.04592	0.9790

[1] Pipette referred to is the 1 mL disposable pipette used in the research field tests

Test # 1

Responsive partner.
Exceptional outcomes.

Field Analyst(s):

Date: _____

Site: _____

Product Tested: Control

Mixing Method: No Mixing Method

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial					

Notes:

- The control is a reference that can be used to compare the results from the products that are tested.
- There are no products tested in the control.

Test # 2

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Floc 06 (Innovative Turf Solutions)

Test Volume: _____

Mixing Method: Rapid Mix (Shaking)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 3

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: SCI-CW-A0 (Standard Contracting)

Test Volume: _____

Mixing Method: Rapid Mix (Shaking)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 5

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Liquifloc 1% (Dober)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

Test # 7

Responsive partner.
Exceptional outcomes.

Indicate Field Analyst(s):

Date: _____

Site: _____

Product Tested: Biostar-CH 2% (Hild and Associates)

Test Volume: _____

Mixing Method: Slow Mix (Stirring)

Rapid Test : Add large product dose to sample

Significant Reaction Observed? Y N

Reduction goal achieved visually? Y N

If yes, complete remainder of worksheet

Mixing/Dosing Guidance:

Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows for settling). Repeat until desired results. If results are not achieved within the first few "drops", increase the number of "drops" for each dose to 2+ until desired results are achieved.

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final					

Dosing Table:

Starting Time (clock): _____

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)

Notes:

* If filtration is used in the full scale floc removal plan, use a similar product to test post-filter NTU at bench test scale.

APPENDIX E

TASK 5: PROCEDURES TO SCALE TEST KIT RESULTS

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin and Jeff Strom, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Procedure to Scale Tailgate Test Kit Results

This memo summarizes the procedure to scale product test results to full scale product application. The procedure includes 7 steps necessary to obtain the total product required to treat the total water volume, identify the product dose rate to treat the construction stormwater discharge rate, and to monitor/adjust as necessary to achieve target reduction goal. An example scenario is provided in Attachment A.

Step 1:

- Determine/estimate the total volume of water to be treated (cubic feet (cf), or gallons (gal)).

Step 2:

- Identify the construction stormwater discharge rate that is going to be treated (cubic feet per second (cfs), or gallons per minute (gpm)).

Step 3:

- Select the product to scale. This was identified through performing the product test worksheets on the sample.

Step 4:

- Identify the effective product dose needed to treat 1 liter of sample volume. The product dose is the cumulative dose that was needed to achieve the target turbidity on the product test worksheet. This is likely a measurement in "drops". Convert sample volume to units of Step 1. One liter is 0.264172 gallons, or 0.0353147 cubic feet.

Step 5:

- Calculation 1 – Estimate total product needed to treat the total volume to turbidity goal. Watch units when performing calculation. Convert calculation result units as needed. Obtain product weight conversion information from the product manufacturer or the product conversion tables from the Tailgate Test Kit Worksheets.

$$\textbf{Calculation 1} = \frac{\textbf{Step 1} \times \textbf{Step 4 Effective Dose} \times \textbf{Product Weight Per Dose}}{\textbf{Step 4 Sample Volume}}$$

Step 6:

- Calculation 2 – Estimate the product dose rate to treat the construction stormwater discharge rate from Step 2. Watch units when performing calculation. Convert calculation result units as needed.

$$\boldsymbol{Calculation\ 2} = \frac{\boldsymbol{Calculation\ 1} \times \boldsymbol{Step\ 2}}{\boldsymbol{Step\ 1}}$$

Step 7:

- Monitor reduction results during full scale product application. Adjust dose rate as necessary to achieve target turbidity goal.

Useful Conversions

- 1 cubic foot = 7.48052 gallons
- 1 cubic foot = 28.3168 Liters
- 1 gallon = 3.78541 Liters
- 1 pound = 453.592 grams

Attachment A

Example Scenario

Example Scenario

Example Tailgate Test with the following site conditions:

- Effluent Turbidity = 1,000 NTU
- Turbidity Goal for Site = 50 NTU
- Volume of Water to be Treated = 25,000 gallons
- Stormwater Discharge Flow Rate = 100 gpm
- Test Sample Volume = 1 Liter
- Product Weight = 0.065 grams per drop

Step 1:

- 25,000 gallons

Step 2:

- 100 gpm

Step 3:

- Example Product A

Step 4:

- Dose is 4 drops to treat 1 Liter to target turbidity goal of 50 NTU (See Figure 1). One liter is 0.264172 gallons

Step 5:

$$\boldsymbol{Calculation\ 1 = \frac{25{,}000\ gal \times 4\ drops \times 0.065\ grams\ per\ drop}{0.264172\ gal} = 24{,}605\ grams = 54.25\ lbs}$$

- The total product needed is approximately 55 lbs.

Step 6:

$$\boldsymbol{Calculation\ 2 = \frac{54.25\ lbs \times 100\ gpm}{25{,}000\ gal} = 0.22\ lbs\ per\ min = 98\ grams\ per\ min}$$

- The product dose rate to treat 100 gpm is 0.22 lbs per minute.

Step 7:

The reduction results were monitored and no adjustment to the product dose rate was necessary to meet the target turbidity goal.

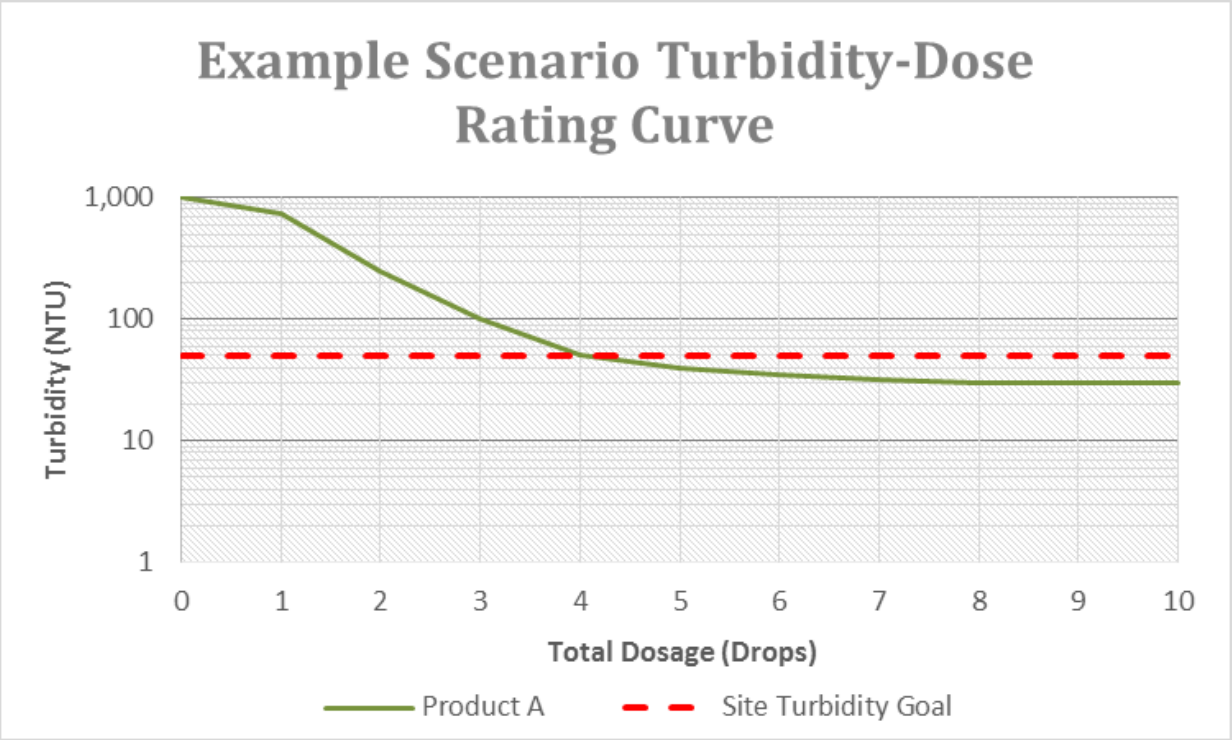


Figure 1. Example Turbidity-Dose Rating Curve

APPENDIX F

TASK 5: PROCEDURES TO TEST NEW PRODUCTS

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin and Jeff Strom, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Procedure to Test New Products and Develop a Worksheet

This memo summarizes the procedure for testing a new product and developing a test worksheet for use with the Tailgate Test Kit. The procedure is described through the following steps.

Step 1:

- Contact manufacturer to obtain a sample of the product. Often times manufacturers will provide a sample of their product free of charge for testing purposes.
- Obtain available product information from the manufacturer. Product information includes:
  - Material Safety Data Sheet (MSDS)
  - Mixing Guidelines
  - Dosing Guidelines
  - Other General Product Information Documents

Step 2:

- Test the product on 3-5 construction stormwater discharge samples. Collect a sufficient amount of sample in case multiple tests are needed. Ideally, samples should be collected at different sites to demonstrate varying levels of turbidity, soil conditions, water chemistry, and other geologic/geographic conditions.
- If construction stormwater discharge samples cannot be collected, synthetic samples may be created by collecting soil samples and mixing them with water representative of the project site (preferred), or distilled water. Construction stormwater discharge samples are preferred because the samples are representative of real conditions.

Step 3:

- Review manufacturer mixing and dosing guidelines.
- Begin test of new product following manufacturer mixing and dosing guidelines.
- Depending on product and manufacturer recommendations, typically, first a product dose is added to the sample, the sample is mixed, and then the sample is observed for a reaction. Based on previous test development, mixing phases were identified as 5-10 seconds, and observation phases were the remainder of 30-60 seconds.
- If a reaction is noticed, a turbidity measurement should be collected for developing dose-turbidity curves. Based on previous test development, a turbidity measurement after 5 minutes (from dose time) provided good estimates. Turbidity will decrease as the allowed settling time is increased, but this directly impacts the length of the test.
- Repeat the dose, mixing, observation, and turbidity measurement as needed to achieve the turbidity goal.

- Repeat Step 3 as needed to develop the dosing and mixing recommendations.
- Take notes and observations that can be used to develop the worksheet that includes the recommended mixing and dosing guidelines.

Step 4:

- After testing 3-5 samples, review the results and make a determination if a worksheet should be developed for the product and included in the Tailgate Test Kit.
- The worksheet should include the mixing and dosing guidelines, and a table for data collection. Review other product worksheets for guidance.

Step 5:

- It is important to identify the product weight conversions that are helpful with scaling test results to full scale application.

    - Determine the measurement (1 drop (spoon) or 1 drop (pipette)) volume equivalent in mL.
    - Determine the weight equivalent (g) for the measurement.
    - Calculate the density (g/mL)

APPENDIX G
RESULTS

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Results Memorandum

1. Introduction

This memo summarizes the results collected while performing the product tests for the Tailgate Test Study. Worksheets were developed for thirteen tests to provide guidance for testing the products/product combinations. The thirteen tests that were performed include:

- Test 1 – Control (No Products Tested)
- Test 2 – Floc 06
- Test 3 – SCI-CW-A0
- Test 4 – Earth Poly-Stable Plus
- Test 5 – Liquifloc 1%
- Test 6 – LB2101 (first) then Liquifloc 1% (second)
- Test 7 – Biostar-CH 2%
- Test 8 – APL Bridger
- Test 9 – Biostar-CH 2% (first) then APL Bridger (second)
- Test 10 – APL Bridger (first) then Biostar-CH 2% (second)
- Test 11 – APS 703d#3 Floc Log
- Test 12 – APS 706b Floc Log
- Test 13 – APS 703d#3 Floc Log and APS 706b Floc Log (Simultaneously)

Eight samples were collected, three were synthetic samples and five were construction stormwater discharge samples. The eight samples collected include:

- Test Sample – Synthetic Sample
- Sample 1 – Discharge Sample
- Sample 2 – Discharge Sample
- Sample 3 – Discharge Sample
- Sample 4 – Synthetic Sample
- Sample 5 – Grab Sample
- Sample 6 – Grab Sample
- Sample 7 – Synthetic Sample

For this study, the target turbidity goal was 50 NTU.

2. Sample Results Summary

Tables 1 through 9 summarize results that were obtained while performing the 13 tests on the eight samples. The following information is included in the tables.

Test – The test that was completed that the results correspond to.

Significant Reaction – General observation to indicate if the product was causing a noticeable reaction and turbidity reduction.

Turbidity Goal <50 NTU – Did the test meet the study target turbidity goal of 50 NTU.

Total Dose for Test – This is the total product dose that was added during the test. This is not necessarily the dose that was required to achieve the target turbidity goal.

Initial pH – The initial pH of the sample. The initial pH is from Test 1, the control test, except for the Test Sample which was tested over multiple days.

Final pH – After product was added and the test was complete, the final pH was measured.

Initial NTU - The initial turbidity measurement of the sample. The initial NTU is the turbidity measurement from Test 1, the control test, except for the Test Sample which was tested over multiple days.

Final NTU (Unfiltered) - After product was added and the test was complete, the final turbidity was measured.

Final NTU (Filtered) - After product was added and the test was complete, the sample was filtered through a coffee filter and then the turbidity was measured.

NTU Measurement after all Tests Completed – After all tests were completed for the sample, the turbidity was re-measured for each test. This measurement accounts for additional time for floc particles to settle.

Percent Reduction (Initial to Final Unfiltered) – The percent reduction that was calculated from initial turbidity measured to the final unfiltered turbidity measurement.

Filtration Percent Reduction (Final Unfiltered to Final Filtered) – The percent reduction that was calculated from the measured final turbidity unfiltered to the final turbidity filtered measurement.

2.1. Test Sample Results

A summary of the results for each test performed on the Test Sample are provided in Table 1.

Results
Significant reactions were observed for the 12 product tests, and all 12 product tests performed met the turbidity goal of 50 NTU.

Between 13% to 53% reduction was measured from filtering the final tested samples. However, since all 12 product tests (minus control) met the turbidity goal, the filtering did not result in additional tests meeting the turbidity goal.

The initial pH for Sample 4 was 7.69. Only minor changes in pH (<1.0) were observed from the initial to final measurements for the tests.

Table 1. Test Sample Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	7.69	7.69	>1000	>1000	>1000	-	0%	0%
2	Yes	Yes	2 Drops	7.69	7.02	>1000	0.540	0.828	-	100%	-53%
3	Yes	Yes	2 Drops	7.69	7.68	>1000	10.86	7.321	-	99%	33%
4	Yes	Yes	35 Drops	7.69	-	>1000	64.18	32.96	-	94%	49%
5	Yes	Yes	10 Drops	7.69	7.27	>1000	31.28	19.51	-	97%	38%
6	Yes	Yes	4 Drops	7.69	7.15	>1000	8.758	7.621	-	99%	13%
7	Yes	Yes	6 Drops	7.23	-	>1000	31.59	20.29	-	97%	36%
8	Yes	Yes	6 Drops	7.23	7.93	>1000	65.68	32.90	-	93%	50%
9	Yes	Yes	6 Drops	7.23	7.62	>1000	43.49	24.29	-	96%	44%
10	Yes	Yes	6 Drops	7.23	7.57	>1000	48.14	22.46	-	95%	53%
11	Yes	Yes	20 min	7.40	7.40	>1000	23.15	16.63	-	98%	28%
12	Yes	Yes	15 min	7.40	7.79	>1000	15.30	11.45	-	98%	25%
13	Yes	Yes	15 min	7.40	7.62	>1000	30.82	23.26	-	97%	25%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.2. Sample 1 Results

A summary of the results for each test performed on Sample 1 are provided in Table 2.

Results
Eleven of the product tests observed significant reactions, but only seven of the product tests performed met the turbidity goal of 50 NTU. The tests that met the turbidity goal include:

- Test 2 – Floc 06
- Test 3 – SCI-CW-A0
- Test 5 – Liquifloc 1%
- Test 6 – LB2101 (first) then Liquifloc 1% (second)
- Test 7 – Biostar-CH 2%
- Test 8 – APL Bridger
- Test 9 – Biostar-CH 2% (first) then APL Bridger (second)
- Test 10 – APL Bridger (first) then Biostar-CH 2% (second)

Between 11% to 82% reduction was measured from filtering the final tested samples. Filtering did result in an additional test meeting the turbidity goal. The test that met the goal due to filtering was:

- Test 8 – APL Bridger

The initial pH for Sample 1 was 7.46. Only minor changes in pH (<1.0) were observed from the initial to final measurements for 11 of the product tests. Test 2 was the only test where the pH varies significantly between initial and final (final pH of 5.69).

Table 2. Sample 1 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	7.46	7.46	>1000	>1000	>1000	-	0%	0%
2	Yes	Yes	5 Drops	7.46	5.69	>1000	19.57	3.463	-	98%	82%
3	Yes	Yes	7 Drops	7.46	7.28	>1000	28.95	20.32	-	97%	30%
4	No	No	37 Drops	7.46	7.11	>1000	97.63	74.51	-	90%	24%
5	Yes	Yes	10 Drops	7.46	7.26	>1000	22.34	12.28	-	98%	45%
6	Yes	Yes	20 Drops	7.46	7.07	>1000	33.90	24.11	-	97%	29%
7	Yes	Yes	8 Drops	7.46	7.25	>1000	21.69	14.38	-	98%	34%
8	Yes	No	8 Drops	7.46	7.38	>1000	58.92	41.31	-	94%	30%
9	Yes	Yes	8 Drops	7.46	7.29	>1000	20.68	11.00	-	98%	47%
10	Yes	Yes	8 Drops	7.46	7.21	>1000	23.70	9.688	-	98%	59%
11	Yes	No	15 min	7.46	7.21	>1000	138.4	123.4	-	86%	11%
12	Yes	No	15 min	7.46	7.28	>1000	139.1	121.0	-	86%	13%
13	Yes	No	15 min	7.46	7.13	>1000	123.2	103.9	-	88%	16%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.3. Sample 2 Results

A summary of the results for each test performed on Sample 2 are provided in Table 3.

Results
Eleven of the product tests observed significant reactions, but only six of the product tests performed met the turbidity goal of 50 NTU. The tests that met the turbidity goal include:

- Test 2 – Floc 06
- Test 5 – Liquifloc 1%
- Test 6 – LB2101 (first) then Liquifloc 1% (second)
- Test 7 – Biostar-CH 2%
- Test 9 – Biostar-CH 2% (first) then APL Bridger (second)
- Test 10 – APL Bridger (first) then Biostar-CH 2% (second)

Between 6% to 63% reduction was measured from filtering the final tested samples. Filtering did result in one additional test meeting the turbidity goal. The test that met the goal due to filtering was:

- Test 3 – SCI-CW-A0

The turbidity was re-measured for each test after all the tests were complete. The additional settling time resulted in one test meeting the turbidity goal. The test that met the goal due to additional settling time was:

- Test 3 – SCI-CW-A0

The initial pH for Sample 2 was 7.04. Only minor changes in pH (<1.0) were observed from the initial to final measurements for the tests.

Table 3. Sample 2 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	7.04	7.04	>1000	>1000	>1000	>1000	0%	0%
2	Yes	Yes	3 Drops	7.04	6.29	>1000	26.74	10.02	6.056	97%	63%
3	Yes	No	7 Drops	7.04	7.40	>1000	57.12	47.02	45.61	94%	18%
4	No	No	21 Drops	7.04	7.23	>1000	>1000	>1000	>1000	0%	0%
5	Yes	Yes	6 Drops	7.04	7.18	>1000	41.27	30.52	19.87	96%	26%
6	Yes	Yes	5 Drops	7.04	6.81	>1000	45.96	32.50	28.01	95%	29%
7	Yes	Yes	6 Drops	7.04	6.73	>1000	35.18	24.83	27.22	96%	29%
8	Yes	No	8 Drops	7.04	6.83	>1000	134.2	125.7	119.4	87%	6%
9	Yes	Yes	8 Drops	7.04	6.62	>1000	31.54	21.46	29.09	97%	32%
10	Yes	Yes	8 Drops	7.04	6.73	>1000	32.97	19.46	25.49	97%	41%
11	Yes	No	290 min	7.04	6.50	>1000	152.2	132.8	57.20	85%	13%
12	Yes	No	290 min	7.04	6.81	>1000	-	-	-	-	-
13	Yes	No	290 min	7.04	6.54	>1000	94.90	62.86	66.60	91%	34%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.4. Sample 3 Results

A summary of the results for each test performed on Sample 3 are provided in Table 3.

Results
None of the product tests performed met the turbidity goal of 50 NTU, and only Two of the product tests observed significant reactions.

Filtering did not impact the results.

The turbidity was re-measured for each test after all the tests were complete. The additional settling time resulted in three tests meeting the turbidity goal. The tests that met the goal due to additional settling time were:

- Test 2 – Floc 06
- Test 5 – Liquifloc 1%
- Test 10 – APL Bridger (first) then Biostar-CH 2% (second)

The initial pH for Sample 3 was 8.14. Only minor changes in pH (<1.0) were observed from the initial to final measurements for 11 of the product tests. Test 2 was the only test where the pH varies significantly between initial and final (final pH of 5.53).

Observations
While performing the test, initial product testing performed did not meet the target turbidity goal. It was noticed that after all test were completed the additional settling time allowed floc to settle which was not observed while tests were performed. There was a significant amount of floc that filled most of the water column. Based on this observation, the initial turbidity was significantly greater than 1000 NTU but could not be quantified.

Table 3. Sample 3 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	8.14	8.14	>1000	>1000	>1000	>1000	0%	0%
2	No	No	16 Drops	8.14	5.53	>1000	>1000	>1000	5.160	0%	0%
3	No	No	30 Drops	8.14	7.79	>1000	399.1	391.8	377.7	60%	2%
4	No	No	4 Drops	8.14	7.85	>1000	587.6	-	635.6	41%	-
5	Yes	No	38 Drops	8.14	7.45	>1000	80.12	100.5	38.16	92%	-25%
6	No	No	12 Drops	8.14	7.24	>1000	>1000	>1000	>1000	0%	0%
7	No	No	29 Drops	8.14	7.73	>1000	763.5	760.2	612.4	24%	0%
8	No	No	33 Drops	8.14	8.00	>1000	>1000	>1000	>1000	0%	0%
9	No	No	40 Drops	8.14	7.75	>1000	573.7	549.8	486.8	43%	4%
10	Yes	No	48 Drops	8.14	7.43	>1000	233.4	-	50.16	77%	-
11	No	No	290 min	8.14	7.78	>1000	>1000	>1000	757.2	0%	0%
12	No	No	290 min	8.14	7.78	>1000	>1000	>1000	>1000	0%	0%
13	No	No	290 min	8.14	7.59	>1000	>1000	>1000	797.7	0%	0%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.5. Sample 4 Results

A summary of the results for each test performed on Sample 4 are provided in Table 4. After Sample 4 testing was completed, the results from the previous 5 samples were reviewed and a shortened test list was created for testing samples moving forward.

Results
Seven of the 13 product tests observed significant reactions, but only five of the product tests performed met the turbidity goal of 50 NTU. The tests that met the goal include:

- Test 2 – Floc 06
- Test 5 – Liquifloc 1%
- Test 7 – Biostar-CH 2%
- Test 9 – Biostar-CH 2% (first) then APL Bridger (second)
- Test 10 – APL Bridger (first) then Biostar-CH 2% (second)

Between 8% to 75% reduction was measured from filtering the final tested samples, however the filtering did not result in additional tests meeting the turbidity goal.

The turbidity was re-measured for each test after all the tests were complete. The additional settling time resulted in one test meeting the turbidity goal. The test that met the goal due to additional settling time was:

- Test 8 – APL Bridger

The initial pH for Sample 4 was 6.66. Only minor changes in pH (<1.0) were observed from the initial to final measurements for 10 of the product tests. The final pH for Test 2 was 3.91 and the final pH for Test 6 was 4.70.

Table 4. Sample 4 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	6.66	6.66	507.9	507.9	496.6	443.4	0%	2%
2	Yes	Yes	7 Drops	6.66	3.91	507.9	44.20	11.15	11.75	91%	75%
3	Yes	No	10 Drops	6.66	7.35	507.9	146.5	114.9	111.3	71%	22%
4	No	No	35 Drops	6.66	6.85	507.9	492.9	454.5	552.9	3%	8%
5	Yes	Yes	34 Drops	6.66	6.10	507.9	49.00	35.00	21.93	90%	29%
6	Yes	No	12 Drops	6.66	4.70	507.9	102.0	84.00	91.50	80%	18%
7	Yes	Yes	25 Drops	6.66	6.01	507.9	31.36	11.31	8.280	94%	64%
8	No	No	33 Drops	6.66	6.42	507.9	338.3	150.8	22.80	33%	55%
9	Yes	Yes	60 Drops	6.66	6.16	507.9	33.36	21.12	20.76	93%	37%
10	Yes	Yes	64 Drops	6.66	6.57	507.9	40.68	22.81	31.68	92%	44%
11	No	No	300 min	6.66	5.95	507.9	474.9	412.3	323.7	6%	13%
12	No	No	300 min	6.66	6.04	507.9	372.6	337.4	277.9	27%	9%
13	No	No	290 min	6.66	5.90	507.9	395.1	335.8	258.4	22%	15%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.6. Sample 5 Results

Sample 5 consists of three subsamples collected and tested from three separate BMPs at the project site. These three subsamples are referred to as 5-1, 5-2, and 5-3. A summary of the results for Samples 5-1, 5-2, and 5-3 are provided in Tables 5, 6, and 7 respectively.

Results
All four product tests observed significant reactions for Samples 5-1, 5-2, and 5-3. The tests performed on Samples 5-2 and 5-3 were only a rapid test where visual results were observed to have clarity that met the 50 NTU goal. Only three of the product tests performed on Sample 5-1 met the turbidity goal of 50 NTU. The tests that met the goal include:

- Test 3 – SCI-CW-A0
- Test 5 – Liquifloc 1%
- Test 7 – Biostar-CH 2%

Filtered turbidity measurements were only collected for Sample 5-1. Between 57% to 67% reduction was measured from filtering the final tested samples. Filtering did result in one additional test meeting the turbidity goal. The test that met the goal due to filtering was:

- Test 2 – Floc 06

The initial pH for Sample 5-1 was 8.00 and only minor changes in pH (<1.0) were observed from the initial to final measurements for 3 of the product tests. Test 2 was the only test where the pH varied significantly between initial and final (final pH of 6.31). The initial pH for Sample 5-2 was 7.46, and Sample 5-3 was 7.49. Final pH was not measured for Samples 5-2 and 5-3.

Observations
Sample 5-1 was a grab sample collected from the bottom of a filtration basin that had mostly drawn down from the recent rainfall event. Samples 5-2 and 5-3 were grab samples collected from top of the water column of wet ponds. The samples were collected the day after a recent rainfall event.

The three subsamples were collected from separate BMPs at the project site and all had different initial turbidity conditions due to location in the treatment chain and exposure to direct erosion. Although the samples initial turbidity measurements are different, the samples water chemistry and sediment source/soil appeared to be similar. Sample 5-1 with a higher initial turbidity required a lower dose to achieve the target turbidity goal of 50 NTU, and Samples 5-2 and 5-3 with lower initial turbidity required a higher dose to achieve the target turbidity goal. It is interesting that the dose did not relate to initial turbidity for these samples. This may indicate that the dose required may relate to suspended particle size and not the total amount of suspended solids. Samples with larger suspended particles may create larger flocs that can react and floc quicker than samples with smaller particles.

Table 5. Sample 5-1 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	8.00	8.00	>1000	>1000	-	-	0%	-
2	Yes	No	13 Drops	8.00	6.31	>1000	104.0	34.00	-	90%	67%
3	Yes	Yes	12 Drops	8.00	7.94	>1000	38.60	26.00	-	96%	33%
5	Yes	Yes	6 Drops	8.00	7.87	>1000	40.46	34.24	-	96%	15%
7	Yes	Yes	6 Drops	8.00	7.87	>1000	40.57	30.24	-	96%	25%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement

Table 6. Sample 5-2 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	7.46	7.46	282.8	282.8	-	-	0%	-
2	Yes	-	8 Drops	7.46	-	282.8	50.00	-	-	82%	-
3	Yes	-	16 Drops	7.46	-	282.8	50.00	-	-	82%	-
5	Yes	-	15 Drops	7.46	-	282.8	50.00	-	-	82%	-
7	Yes	-	20 Drops	7.46	-	282.8	50.00	-	-	82%	-

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

Table 7. Sample 5-3 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	7.49	7.49	102.5	102.5	-	-	0%	-
2	Yes	-	8 Drops	7.49	-	102.5	50.00	-	-	51%	-
3	Yes	-	16 Drops	7.49	-	102.5	50.00	-	-	51%	-
5	Yes	-	20 Drops	7.49	-	102.5	50.00	-	-	51%	-
7	Yes	-	20 Drops	7.49	-	102.5	50.00	-	-	51%	-

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.7. Sample 6 Results

A summary of the results for each test performed on Sample 6 are provided in Table 8.

Results
All four product tests observed significant reactions, but only three of the product tests performed met the turbidity goal of 50 NTU. The tests that met the goal include:

- Test 2 – Floc 06
- Test 3 – SCI-CW-A0
- Test 7 – Biostar-CH 2%

Between 33% to 48% reduction was measured from filtering the final tested samples. Filtering did result in one additional test meeting the turbidity goal. The test that met the goal due to filtering was:

- Test 5 – Liquifloc 1%

The initial pH for Sample 6 was 8.29. Only minor changes in pH (<1.0) were observed from the initial to final measurements for 11 of the product tests. Test 2 was the only test where the pH varies significantly between initial and final (final pH of 6.63).

Table 8. Sample 6 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	8.29	8.29	517.8	517.8	-	-	0%	-
2	Yes	Yes	5 Drops	8.29	6.63	517.8	18.65	10.91	-	96%	42%
3	Yes	Yes	12 Drops	8.29	8.10	517.8	48.43	28.67	-	91%	41%
5	Yes	No	20 Drops	8.29	7.89	517.8	59.76	40.16	-	88%	33%
7	Yes	Yes	20 Drops	8.29	7.66	517.8	46.52	24.42	-	91%	48%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

2.8. Sample 7 Results

A summary of the results for each test performed on Sample 7 are provided in Table 9.

Results
All four product tests observed significant reactions, but only one of the product tests performed met the turbidity goal of 50 NTU. The test that met the goal is:

- Test 2 – Floc 06

Between 21% to 63% reduction was measured from filtering the final tested samples, however the filtering did not result in additional tests meeting the turbidity goal.

The turbidity was re-measured for each test after all the tests were complete. The additional settling time resulted in a test meeting the turbidity goal. The test that met the goal due to additional settling time was:

- Test 5 – Liquifloc 1%

The initial pH for Sample 7 was 9.58. Only minor changes in pH (<1.0) were observed from the initial to final measurements for 11 of the product tests. Test 2 was the only test where the pH varies significantly between initial and final (final pH of 7.61).

Table 9. Sample 7 Results

Test	Significant Reaction	Turbidity Goal <50 NTU	Total Dose for Test[1]	Initial pH	Final pH	Initial NTU	Final NTU (Unfiltered)	Final NTU (Filtered)	NTU Measurement After All Tests Completed	Percent Reduction (Initial to Final Unfiltered)	Filtration Percent Reduction (Final Unfiltered to Final Filtered)
1 (control)	-	-	-	9.58	9.58	>1000	>1000	-	-	0%	-
2	Yes	Yes	5 Drops	9.58	7.61	>1000	45.43	16.87	19.14	95%	63%
3	Yes	No	28 Drops	9.58	8.93	>1000	224.1	164.6	188.1	78%	27%
5	Yes	No	29 Drops	9.58	8.60	>1000	183.0	118.6	28.94	82%	35%
7	Yes	No	37 Drops	9.58	8.70	>1000	216.4	171.8	107.1	78%	21%

- No Data available
[1] For Tests 11, 12, and 13 the product is added and passive dosing is instead a time dependent measurement.

3. Product Test Results and Observations Summary

Section 3 discusses results and observations for each product. Additional results for each product are presented in Tables 1 through 9 of Section 2.

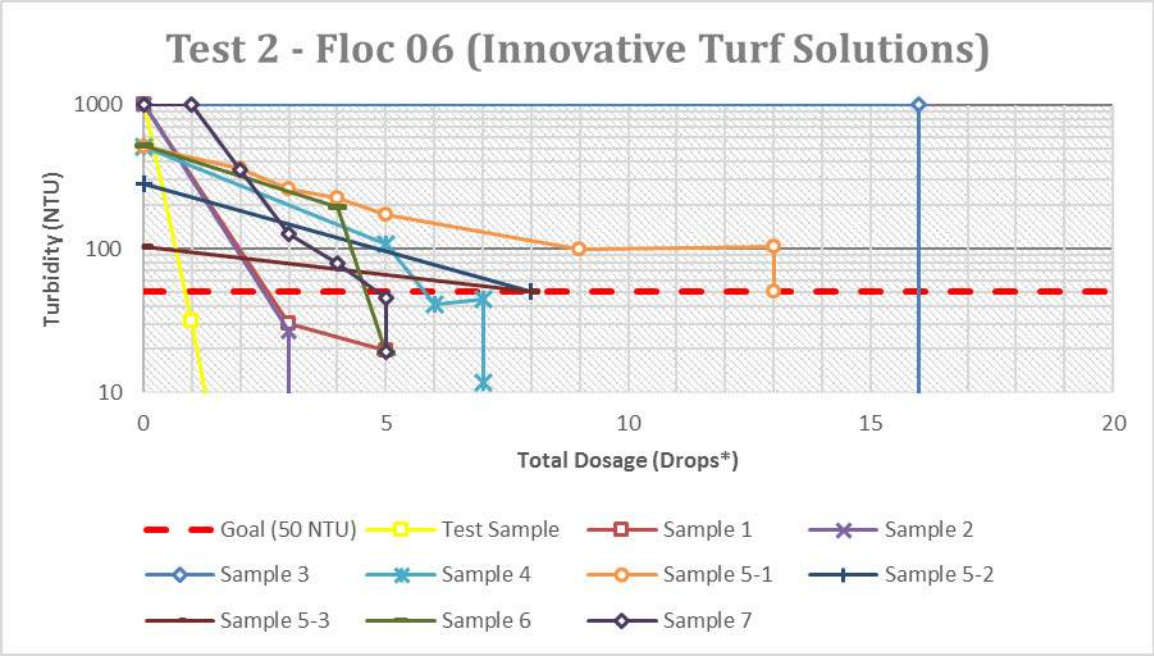
3.1. Test 1 – Control Results

Test 1 is the control test. The purpose of the control test is to measure the initial sample conditions for comparison to the product tests. There are no specific results to discuss for test 1.

3.2. Test 2 – Floc 06 Results

Test 2 is the product Floc 06 test and was performed on all eight samples. The Floc 06 dose-turbidity results for each sample tested are presented in Figure 1.

Figure 1. Test 2 - Floc 06 Dose-Turbidity Curve



*Measurement Spoon "Drop"

Results
The target turbidity goal of 50 NTU was achieved for all samples, however, the goal was not initially reached for Samples 3 and 5-1. The turbidity goal was reached for Samples 3 and 5-1 after additional settling time. For a couple of the samples, a final turbidity measurement was taken after all 13 tests were completed to check how additional settling time affected the turbidity reduction. For the Floc 06 product, it was shown that additional reduction benefit was measured after additional settling time. This measurement is shown in Figure 1 as the drop in turbidity at the final dose. Also, the results presented in Tables 1 through 9 show that the Floc 06 product can cause a shift in the pH of the sample.

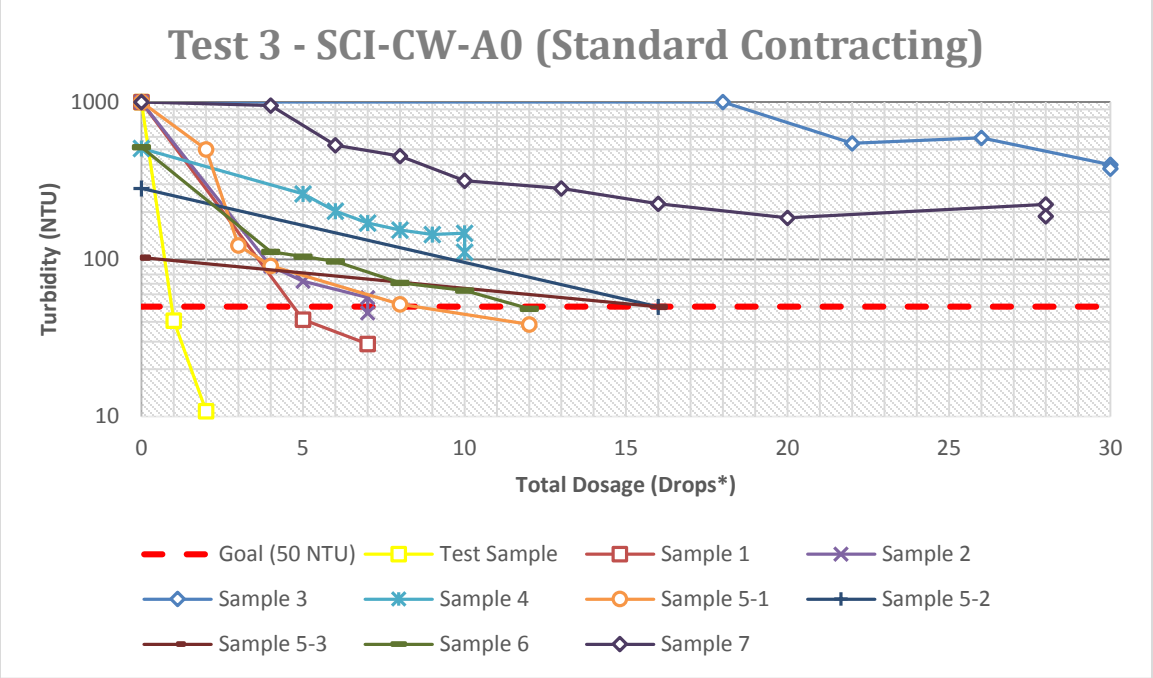
Visual Observations

Once the reaction occurred, the floc that formed was generally a large floc. For several samples, it was observed that the floc floated or a portion floated to the surface. Based on conversations with the manufacturer, this is due to hydrocarbons, pigments, or dyes present in the sample.

3.3. Test 3 – SCI-CW-A0 Results

Test 3 is the product SCI-CW-A0 test and was performed on all eight samples. The SCI-CW-A0 dose-turbidity results for each sample tested are presented in Figure 2.

Figure 2. Test 3 - SCI-CW-A0 Dose-Turbidity Curve



*Measurement Spoon "Drop"

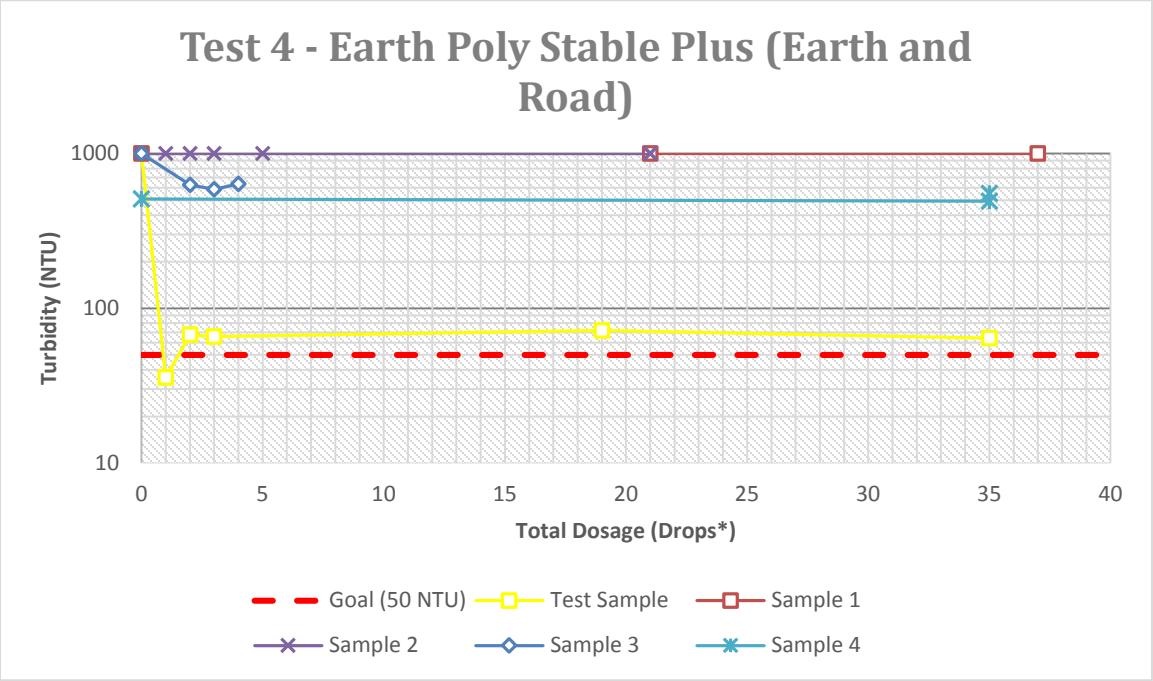
Results
The target turbidity goal of 50 NTU was achieved for five of the eight samples. For several of the samples, a final turbidity measurement was taken after all 13 tests were completed to check how additional settling time affected the turbidity reduction. For the SCI-CW-A0 product, it was shown that additional settling time did not provide a significant decrease in turbidity. This measurement is shown in Figure 2 as the drop in turbidity at the final dose as seen in samples 2 and 7.

Visual Observations
Once the reaction occurred, the floc that formed was generally a fine floc. For the samples that did not achieve the turbidity goal, it was observed that a reaction and floc did form, however, the sample was still turbid and additional product did not greatly improve the clarity.

3.4. Test 4 – Earth Poly-Stable Plus Results

Test 4 is the product Earth Poly-Stable Plus test and was performed on five samples. Test 4 was not included in the shortened test list for the Tailgate Test Kit and was not tested on the last three samples that were collected due to poor performance. The Earth Poly-Stable Plus dose-turbidity results for each sample tested are presented in Figure 3.

Figure 3. Test 4 - Earth Poly Stable Plus Dose-Turbidity Curve



*Measurement Spoon "Drop"

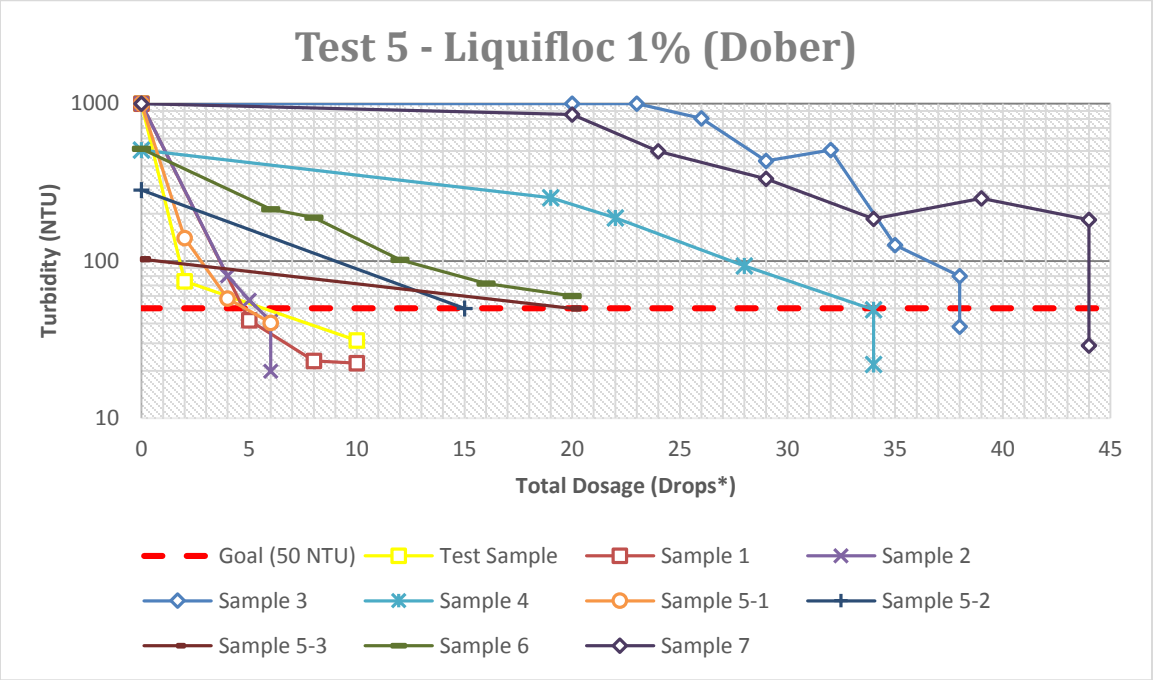
Results
The target turbidity goal of 50 NTU was not achieved for any of the samples that were tested. After the first dose added to the Sample Test, the turbidity measured was lower than the turbidity goal, however, after additional product was added the turbidity that was measured did not achieve the goal. This may be due to the fact that the floc particles could not settle because the sample would develop a thick/syrupy texture.

Visual Observations
It was observed that after dosing the sample would develop a thick/syrupy texture. Floc formulation was observed in the Test Sample but not the other samples that were tested. The floc that was observed was fine.

3.5. Test 5 – Liquifloc 1% Results

Test 5 is the product Liquifloc 1% test and was performed on all eight samples. The Liquifloc 1% dose-turbidity results for each sample tested are presented in Figure 4.

Figure 4. Test 5 - Liquifloc 1% Dose-Turbidity Curve



*Measurement is a Drop from a 1ml Disposable Pipette

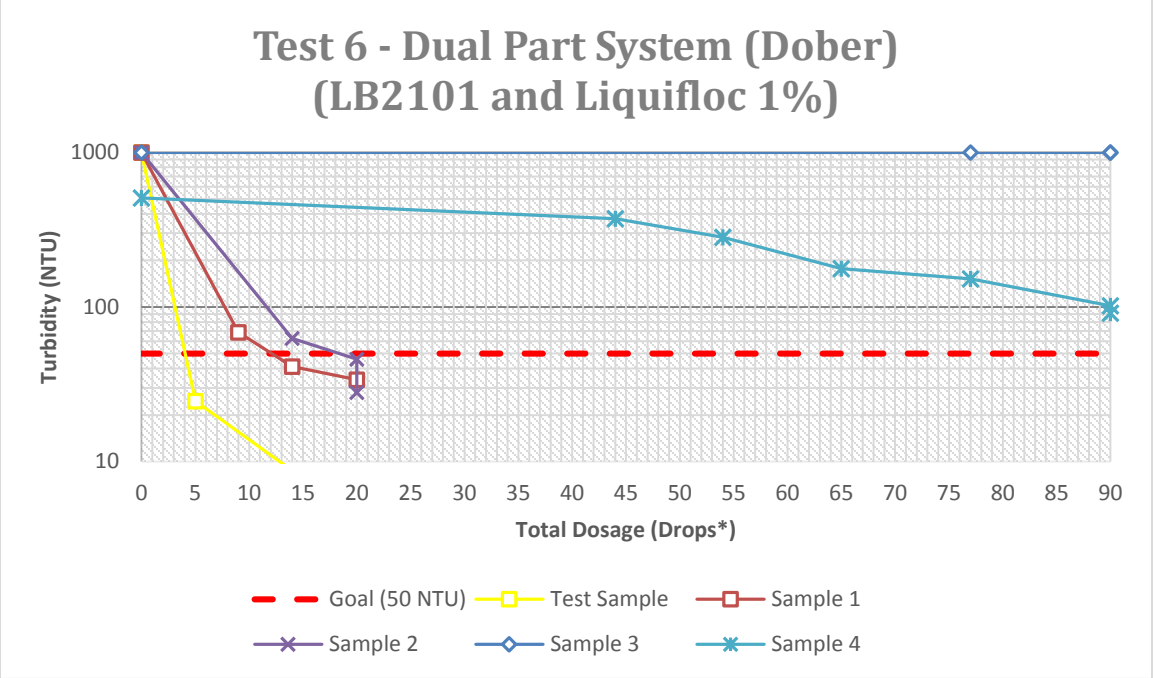
Results
The target turbidity goal of 50 NTU was achieved for seven of the eight samples, however, the goal was not initially reached for Samples 3 and 7. The turbidity goal was reached for Samples 3 and 7 after additional settling time. For several of the samples, a final turbidity measurement was taken after all 13 tests were completed to check how additional settling time affected the turbidity reduction. For the Liquifloc 1% product, it was shown that additional reduction benefit was measured after additional settling time. This measurement is shown in Figure 4 as the drop in turbidity at the final dose. Sample 6 was the only sample that the turbidity goal was not achieved. However, further dosing of Sample 6 may have achieved the goal, and/or additional settling time may have resulted in meeting the goal.

Visual Observations
Once the reaction occurred, the floc that formed was generally a medium floc.

3.6. Test 6 – Dual Part System (LB2101 and Liquifloc 1%) Results

Test 6 is the Dual Part System (LB2101 and Liquifloc 1%) test and was performed on five samples. The results were similar to the results of Liquifloc 1% alone and as a result, the shortened test list for the Tailgate Test Kit did not include Test 6. Test 6 was not tested on the last three. The Dual Part System (LB2101 and Liquifloc 1%) dose-turbidity results for each sample tested are presented in Figure 5.

Figure 5. Test 6 - Dual Part System (LB2101 and Liquifloc 1%) Dose-Turbidity Curve



*Measurement Spoon "Drop"

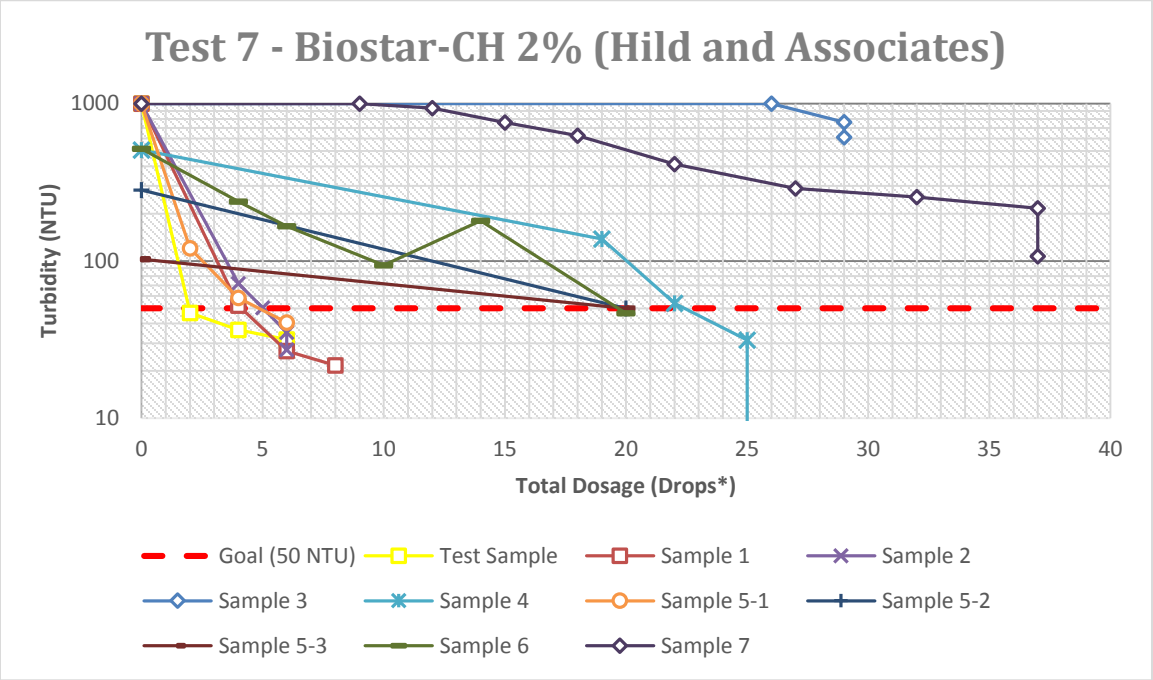
Results
The target turbidity goal of 50 NTU was achieved for three of the five samples.

Visual Observations
Once the reaction occurred, the floc that formed was generally a medium floc. The results were similar to results from testing Liquifloc 1% alone. The total dosage is higher due to the addition of two products compared to liquifloc 1% alone.

3.7. Test 7 – Biostar-CH 2% Results

Test 7 is the product Biostar-CH 2% test and was performed on all eight samples. The Biostar-CH 2% dose-turbidity results for each sample tested are presented in Figure 6.

Figure 6. Test 7 - Biostar-CH 2% Dose-Turbidity Curve



*Measurement is a Drop from a 1ml Disposable Pipette

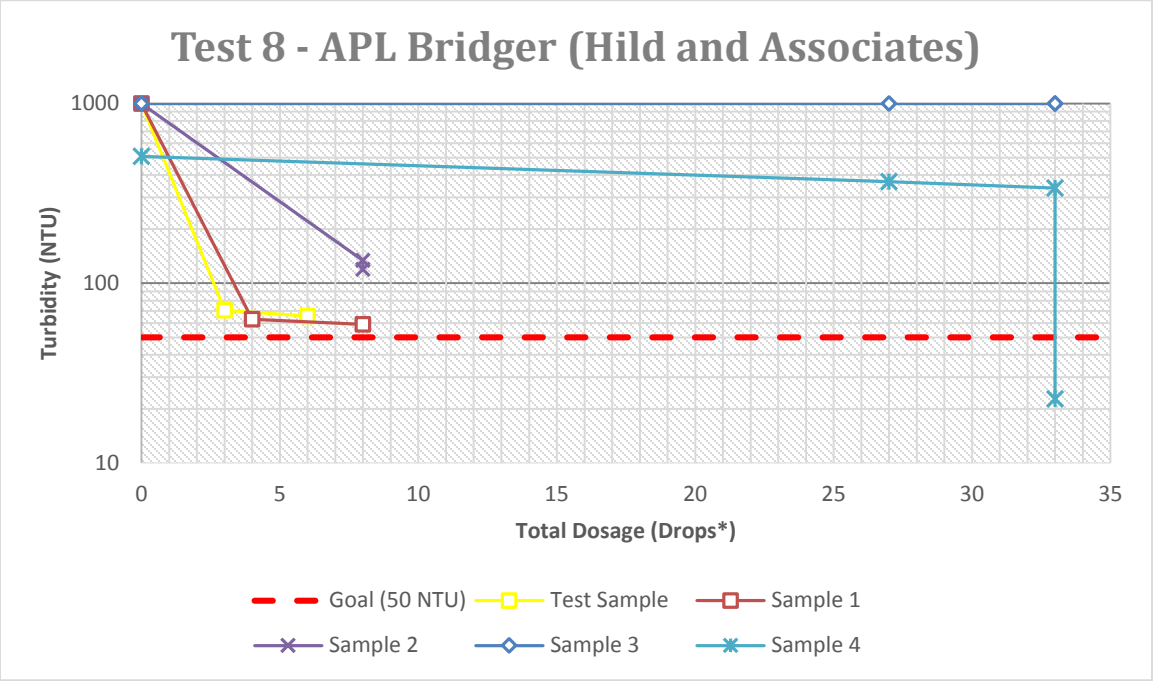
Results
The target turbidity goal of 50 NTU was achieved for six of the eight samples. For several of the samples, a final turbidity measurement was taken after all 13 tests were completed to check how additional settling time affected the turbidity reduction. For the Biostar-CH 2% product, it was shown that additional settling time did provide a decrease in turbidity. This measurement is shown in Figure 6 as the drop in turbidity at the final dose.

Visual Observations
Once the reaction occurred, the floc that formed was generally a medium floc. For the samples that did not achieve the turbidity goal, it was observed that a reaction and floc did form, however, the sample was still turbid and adding product did not greatly improve the clarity.

3.8. Test 8 – APL Bridger Results

Test 8 is the product APL Bridger test and was performed on five samples. Due to the test results, Test 8 was not included in the shortened test list for the Tailgate Test Kit and was not tested on the last three samples. The APL Bridger dose-turbidity results for each sample tested are presented in Figure 7.

Figure 7. Test 8 - APL Bridger Dose-Turbidity Curve



*Measurement is a Drop from a 1ml Disposable Pipette

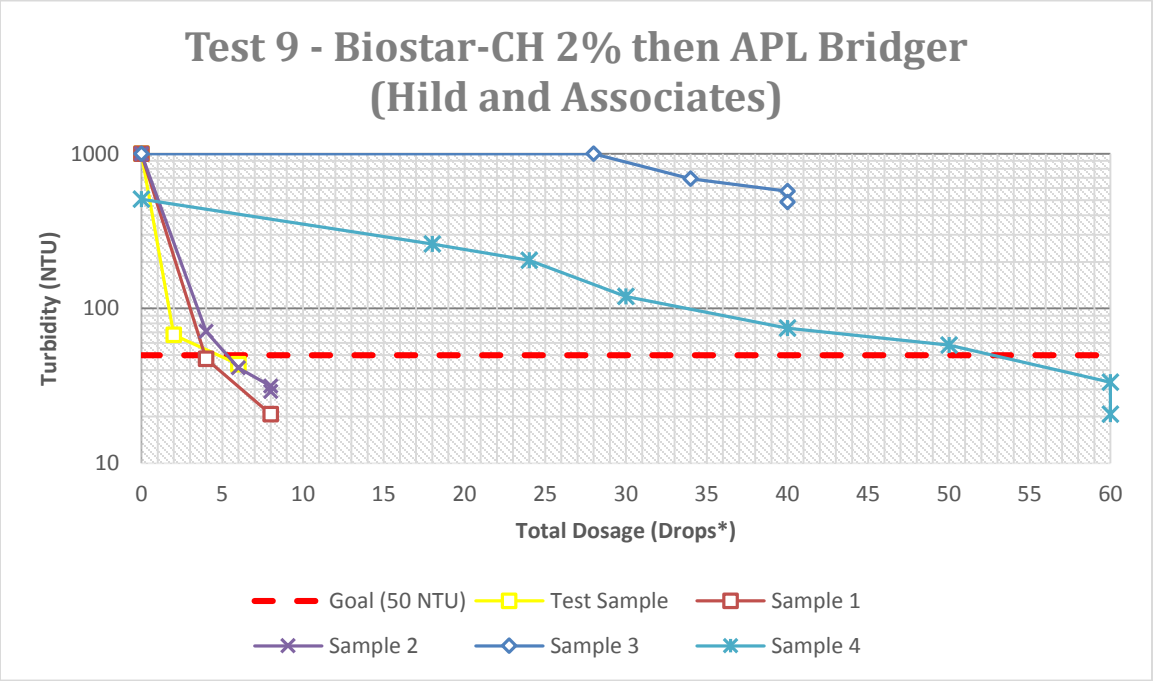
Results
The target turbidity goal of 50 NTU was achieved for one of the five samples, however, the goal was not initially reached. The goal was reached after additional settling time when the sample was retested after all 13 tests were completed. This measurement is shown in Figure 7 as the drop in turbidity at the final dose.

Visual Observations
In general, a significant reduction was observed with the APL Bridger product, however the reduction did not meet the turbidity goal of 50 NTU. Once the reaction occurred, the floc that formed was generally a fine floc. After Product application, the color of the sample was stained compared to the color of other product sample tests. This could be pigment in the water sample that was removed in other product tests.

3.9. Test 9 – Biostar-CH 2% (First) then APL Bridger (Second) Results

Test 9 is a two-part system of Biostar-CH 2% (First) then APL Bridger (Second) and was performed on five samples. The results were similar to the results of Biostar-CH 2% alone and as a result, the shortened test list for the Tailgate Test Kit did not include Test 9. Test 9 was not tested on the last three samples that were collected. The two-part system of Biostar-CH 2% (First) then APL Bridger (Second) dose-turbidity results for each sample tested are presented in Figure 8.

Figure 8. Test 9 - Biostar-CH 2% (First) then APL Bridger (Second) Dose-Turbidity Curve



*Measurement is a Drop from a 1ml Disposable Pipette

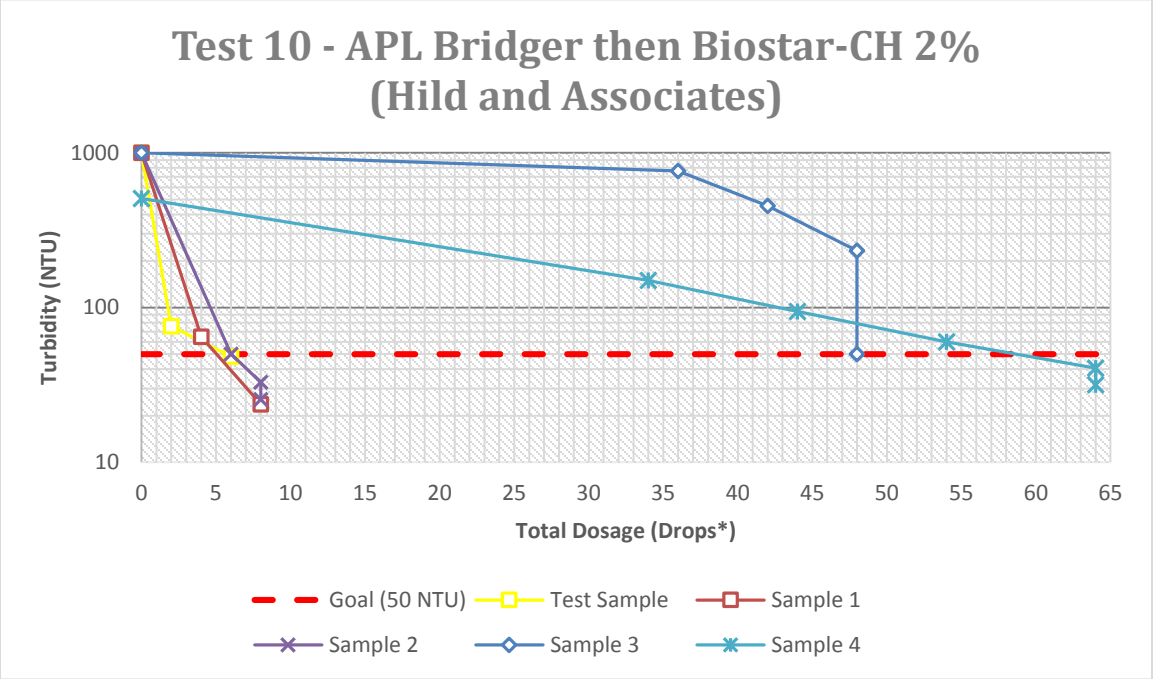
Results
The target turbidity goal of 50 NTU was achieved for four of the five samples.

Visual Observations
Once the reaction occurred, the floc that formed was generally a medium floc. The results were similar to results from testing Biostar-CH 2% alone.

3.10. Test 10 – APL Bridger (First) then Biostar-CH 2% (Second) Results

Test 10 is a two-part system of APL Bridger (First) then Biostar-CH 2% (Second) and was performed on five samples. The results were similar to the results of Biostar-CH 2% alone and also Test 9. As a result, the shortened test list for the Tailgate Test Kit did not include Test 10. Test 10 was not tested on the last three samples that were collected. The two-part system of APL Bridger (First) then Biostar-CH 2% (Second) dose-turbidity results for each sample tested are presented in Figure 9.

Figure 9. Test 10 - APL Bridger (First) then Biostar-CH 2% (Second) Dose-Turbidity Curve



*Measurement is a Drop from a 1ml Disposable Pipette

Results
The target turbidity goal of 50 NTU was achieved for all five samples.

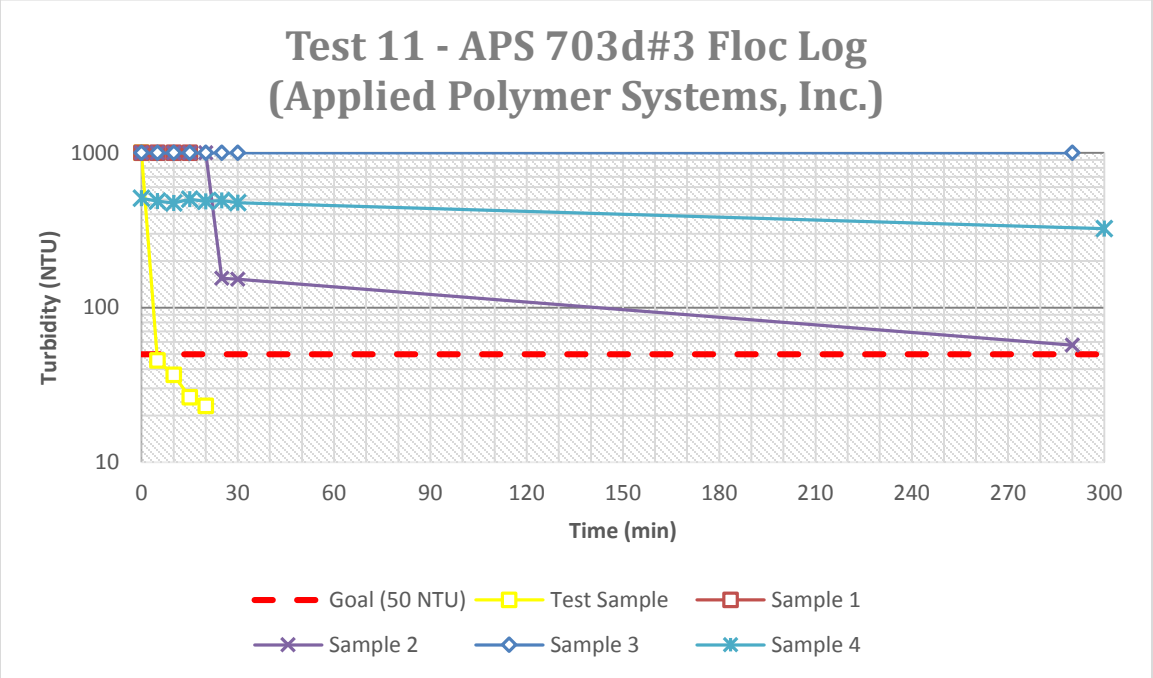
Visual Observations
Once the reaction occurred, the floc that formed was generally a medium floc. The results were similar to results from testing Biostar-CH 2% alone.

3.11. Test 11 – APS 703d#3 Floc Log Results

Test 11 is the product APS 703d#3 test and was performed on five samples. Test 11 was not included in the shortened test list for the Tailgate Test Kit and was not tested on the last

three samples. The APS 703d#3 test dose-turbidity results for each sample tested are presented in Figure 10.

Figure 10. Test 11 - APS 703d#3 Floc Log Dose-Turbidity Curve



Results
The target turbidity goal of 50 NTU was achieved for one of the five samples.

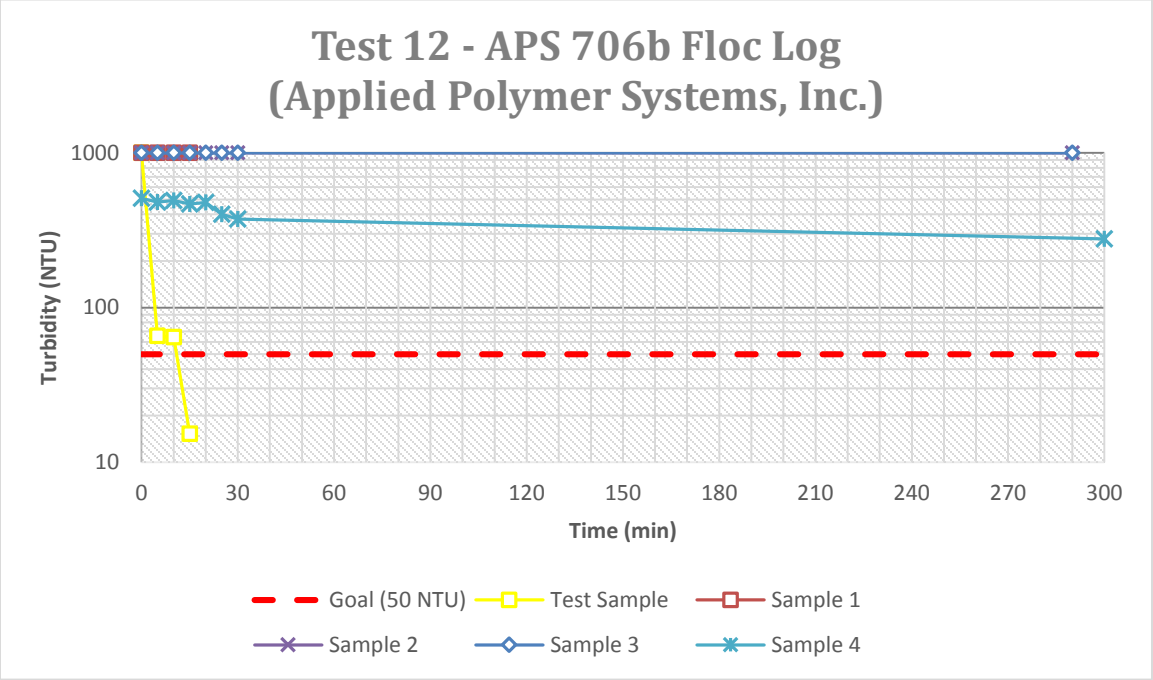
Visual Observations
A significant reaction was observed for two of the samples. For three of the tests, turbidity readings were measured after approximately 290-300 minutes of contact time and the target turbidity goal was not achieved. This contact time is significant in consideration for scaling to full scale application.

3.12. Test 12 – APS 706b Floc Log Results

Test 12 is the product APS 706b test and was performed on five samples. Test 12 was not included in the shortened test list for the Tailgate Test Kit and was not tested on the last

three samples that were collected. The APS 706b test dose-turbidity results for each sample tested are presented in Figure 11.

Figure 11. Test 12 - APS 706b Floc Log Dose-Turbidity Curve



Results
The target turbidity goal of 50 NTU was achieved for one of the five samples.

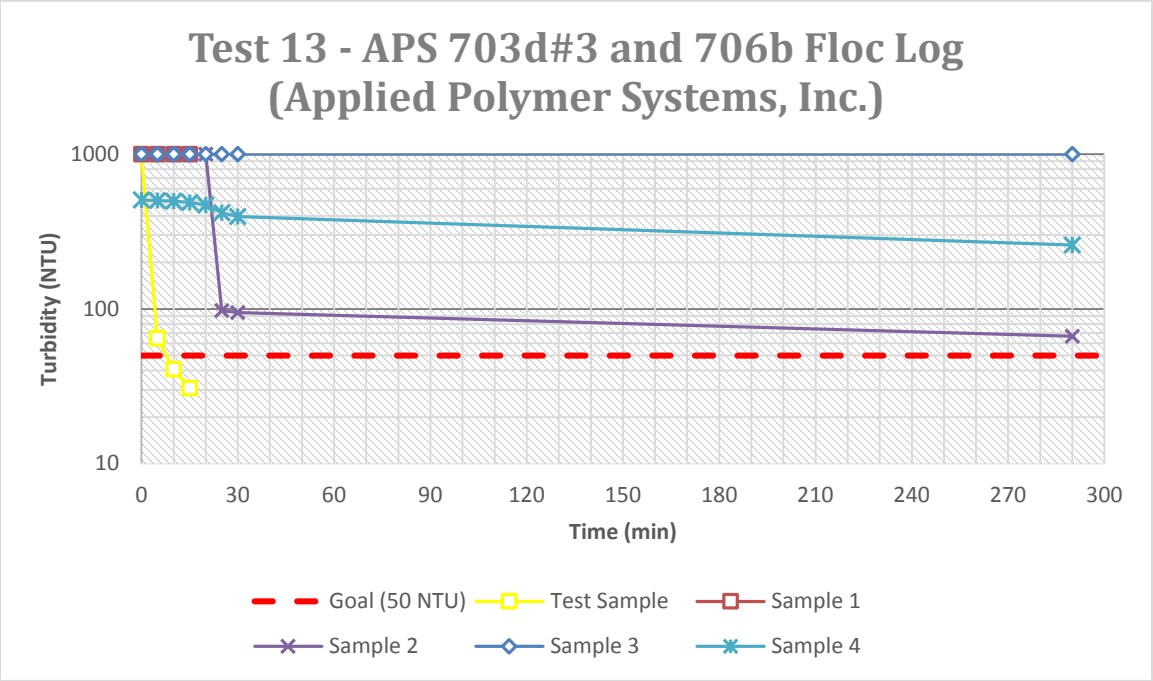
Visual Observations
A significant reaction was observed for only one of the samples. For three of the tests, turbidity readings were measured after approximately 290-300 minutes of contact time and the target turbidity goal was not achieved.

3.13. Test 13 – APS 703d#3 Floc Log and APS 706b Floc Log (Simultaneously) Results

Test 13 is the products APS 703d#3 Floc Log and APS 706b Floc Log (Simultaneously) test and was performed on five samples. Due to the test results, Test 13 was not included in the

shortened test list for the Tailgate Test Kit and was not tested on the last three samples that were collected. The APS 706b test dose-turbidity results for each sample tested are presented in Figure 12.

Figure 12. Test 13 - APS 703d#3 and 706b Floc Log Dose-Turbidity Curve



Results
The target turbidity goal of 50 NTU was achieved for one of the five samples.

Visual Observations
A significant reaction was observed for two of the samples. For three of the tests, turbidity readings were measured after approximately 290 minutes of contact time and the target turbidity goal was not achieved.

APPENDIX H
FIELD NOTES

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Field Notes Memorandum

Samples were collected and tested to develop the Tailgate test kit from eight sites. The field notes collected while performing the tests are included in the following Attachments.

ATTACHMENTS

Attachment A – Test Sample (Synthetic sample made from pond sediments)
Attachment B – Sample 1 (From a discharge hose at a St. Croix River construction site)
Attachment C – Sample 2 (From a discharge hose at a Hwy 53 construction site in northern MN)
Attachment D – Sample 3 (From a discharge hose at a St. Paul Technical College construction site)
Attachment E – Sample 4 (Created from a soil sample and water collected at a Hwy 371 construction site in central MN)
Attachment F – Sample 5 (Grab samples from three separate BMPs from a Hwy 36 and Lex. Ave. construction site in Roseville)
Attachment G – Sample 6 (Runoff grab sample from a Hwy 96 construction site in the north metro)
Attachment H – Sample 7 (Synthetic sample made from a Nemadji River construction site soil and distilled water)

Wenck Associates, Inc. | 7500 Olson Memorial Highway | Suite 300 | Golden Valley, MN 55427
Toll Free 800-472-2232 Main 763-252-6800 Email wenckmp@wenck.com Web wenck.com

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

Attachment A

Test Sample (Synthetic sample made from pond sediments)

Date: 5-25-16 + 6/1/16 & 6/2/16

Site: Wenck Basement (G-V)

Field Analyst(s):

Kirby Templin (Wenck)

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

~~Other~~

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4	X	Earth Poly Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6	X	LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8	X	APL Bridger	Hild and Associates
9	X	Biostar-CH (first) then APL Bridger (second)	Hild and Associates
~~10~~ 10	X	APL Bridger (first) then Biostar-CH (second)	Hild and Associates
~~11~~ 11	X	APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
~~12~~ 12	X	APS 706b Floc Log	Applied Polymer Systems, Inc.
~~13~~ 13	X	APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

5/25/16 — 6/1/16 — 6/2/16

Do we want to do Both 7, forward.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Test #1

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 5-25-16

Field Analyst(s): Kirby Templin, Louis Sigtermans

Site: Wendt Basement (GV)
Synthetic Sample of 12 Tab to 1000 mL

Product Tested: Control

Significant Reaction? Y (N)

reduction 750% Y (N)

Mixing Method: ~~Rapid Mix (Shaking) or Slow Mix (Stirring)~~

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	4:52	20.67	7.69	136.2	
Final (5 min ~~after floc addition~~)	4:57	20.67	7.69		97.75

Reading Suspect

Reading suspect.

Dosing Table:

Time	Dosage	Unit
Total:		

Notes:

~~Approximately how long to get reaction?~~

* This is simply used as a Control for comparison to product results that were tested.

Sheet 1 of 1

Test 2

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 5-25-16

Field Analyst(s): Kirby Templin, Louis Sigtermans

Site: Wenck Basement (GV)
synthetic Sample of 12 TAD to 1000 mL

Product Tested: Floc 06 (Innovative Turf Solutions) **significant Reaction?** (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	2:20pm	20.67	7.69	130.8	[redacted]
Final (X min after floc addition)	2:47	21.27	7.02	0.540	0.828

Results suspect

Dosing Table:

wait

Total Dosage

NTU reading no filter

Time	Dosage		Unit	
2:35pm	1	1	drop	31.63
2:42	1	2	drop	0.540
Total:				

Notes:

Approximately how long to get reaction? 1st dose 30 sec+, second dose less than 20 sec

* filter is simply a coffee filter

* after addition of 2nd drop floc was darker and much larger.

Sheet 1 of 1

Test 3

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 5/25/16

Field Analyst(s): Louis Sytsermans, Kirby Templin

Site: Wenck Basement (GV)
Synthetic Sample of 12 TAD to 1000 mL

Product Tested: SCI-CW-AO (Std. Contracting)

Significant Reaction? (Y) N

Mixing Method: (Rapid Mix (Shaking)) or Slow Mix (Stirring)

reduction greater 50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	11:13 am	20.67	7.69	140.0	
Final (X min after floc addition)	11:40 am	21.62	7.68	10.86	7.321

reading suspect

Dosing Table:

Time	Dosage	Total Dosage	Unit
11:30 am	1 drop	1	drop/spoon
11:37 am	1 drop	2	drop/spoon
Total:			

Notes:

Approximately how long to get reaction? Less than 30 seconds.

*Filter is simply a coffee filter.

Time	Wait	Dosage	Total	NTU reading
				No Filter
11:30 am	5 min	1 drop	1	40.74
11:37 am	5 min	1 drop	2	10.86

Sheet 1 of 1

WENCK ASSOCIATES

Responsive partner. Exceptional outcomes.

Test 4

Date: 5-25-16

Field Analyst(s): Kirby Templin, Louis Sigtermans

Site: Wenck Basement (GV)
Synthetic Sample of 12 TAD to 1000mL

Product Tested: Earth Poly Stable Plus (Earth and Reed) **Significant Reaction?** Y (N)

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% * little reaction (N)

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	2:25 pm	20.67	7.69	107.9	reading suspect
Final (X min after floc addition)	3:18 pm			64.18	32.96

didnot take pH or Temp because of gel That formed in sample

Dosing Table:

wait — Total Dosage — NTU ready no filter

Time	Dosage		Unit	
2:35 pm 5min	1	1	drop	35.70
2:42 pm 5min	1	2	drop	67.56 *
2:49 pm 5min	1	3	drop	65.77
3:00 pm 5min	1 TAD	3 1	drop TAD	71.74
** 3:08 pm 5min	1 TAD	3 2	drop TAD	64.18
Total:				

Notes:

Approximately how long to get reaction? 1st dose N/min after dose No reaction?

* filter is simply a coffee filter

* A reaction occured after 1st dose.
* did not appear to react after 2nd dose....

* might want to follow up with narvin chem to discuss mixing and why No reaction after 2nd dose.

** did not shake for last TAD Dosage.
- There was a Thick gel layer That developed at top of sample in Mixing container.

Test 5

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 5-25-16

Field Analyst(s): Kirby Templin, Louis Sigismund

Site: Welk basement (GV)
Synthetic Sample of 12 Tad to 1000mL

Product Tested: Liquifloc 1070 (Dober)

Significant Reaction? (Y) / N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% (Y)

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	3:30pm	20.67	7.69	115.0	reading suspect
Final (5 min after floc addition)	3:55pm	21.55	7.05	0.302	1.001

5

Dosing Table:

Time	Dosage	total	Unit
3:36pm	1	1	drop
1min 3:37	1	2	drop
2min 3:38	1	3	drop
3min	1	4	drop
4min	1	5	drop
5min	1	6	drops
5:30min	1	7	drops
Total:	1	8	drops
6	1	9	drops
6:30	1	10	drops
7	1	11	drops
7:30	1	12	drops
8	1	13	drops
8:30	1	14	drops
9	1	15	drops
9:30	1	16	drops
10	1	17	drops
10:30	1	18	drops
11	1	19	drops
11:30	1	20	drops
12	10	30	drops
12:30			

Notes:

Approximately how long to get reaction?

*filter is simply a coffee filter.

* did not see reaction occur because of mixing while adding product. will rerun and not mix between addition of product.
-See next sheet for retest of Test 5

* define drop for product 1 drop from sample bottle, sent by manufacturer is "1 drop = measured out spoon"

Sheet 1 of 2

Test 5

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 5-25-16

Field Analyst(s): Kirby Templin, Louis Sigtermans

Site: Wenck Basement (GV)
Synthetic Sample of 12 Tad to 1000mL

Product Tested: Liquiflo 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

Reduction (Y) N
>50%

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	4:05	20.67	7.69	130.9	
Final (15 min after floc addition)	4:30	20.33	7.27	31.28	19.51

reading suspect

Dosing Table: Start time: 4:11

Time (minute)	Dosage	total	Unit
0	2	2	drop
6	1	3	drop
6:30	1	4	drop
7:00	1	5	drop
8:30	1	6	drop
9:30	1	7	drop
10:30	1	8	drop
11:30	1	9	drop
12:30	1	10	drop

Total:

Notes:

← moderate reaction occurred during NTU after 5 min set time

Approximately how long to get reaction? → 74.31

← waited 5 min took NTU reading → 31.28

* stir for 5 seconds, let sit to react for remainder of 1 minute, add as needed. Let stand for 5 minutes for testing NTU. If moderate results after NTU reading add 1 drop wait 1 minute, keep adding 1 drop every 1 minute until good reaction. Then take final NTU readings.

Sheet 2 of 2

Test 6

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 5-25-16

Field Analyst(s): Kirby Templin, Louis Sigfermans

Site: Wenck Basement (GV)
Synthetic sample of 1g Tad to 1000 mL

Product Tested: LB2101 and liquiflo 1% (Dober)
LB2101 stir → liquiflo 1%

Reaction? significant (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial 5:00	[redacted] pm	20.67	7.69	115.1	[redacted]
Final (X min after floc addition)	5:24	21.52	7.15	8.758	7.621

reading suspect

Starting time 5:06 pm

Dosing Table:

~~Time~~ Minute	Dosage Step	Unit
0	1	drop
1:30	2	drop
[redacted]	[redacted]	[redacted]
11	3	Drops
12:30	4	Drops
Total:		

Notes: reaction waited 5 min and took NTU reading 24.65

Approximately how long to get reaction?

* filter is simply a coffee filter.

* 1 drop LB2101 shake 5 seconds
Add 1 drop liquiflo < 1% stir
for 5 seconds wait remainder of 1 minute and do next step
Undergone mixing times.

* When reaction occurs wait 5 minutes for NTU reading.

did 2 more steps for final reaction to test NTU

Dosage Step Guide			
Step	Dose LB2101	Dose liquiflo 1%	Total
1	1	1	1/1
2	2	1	3/2
3	2	2	5/4
4	3	2	8/6
5	3	3	11/9
6	4	3	15/12
7	4	4	19/16
8	5	4	24/20
9	5	5	29/25
10	6	5	35/30
11	6	6	41/36
12	7	6	48/42
13	7	7	55/49
14	8	7	63/56
15	8	8	71/64

Sheet 1 of 1

* Total LB2101 / liquiflo 1%

Test 7

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 6-1-16

Field Analyst(s): Kirby Taylor, Louis Sigismund

Site: Wenck Basement (Lab)
synthetic sample of 1d Tad to 1000 mL

Product Tested: Biostar-CH 2% (Hild and Associates) Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction 750% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	4:07 pm	21.31	7.23	130.7	[illegible]
Final (X min after floc addition)	4:35 pm			31.59	20.29

reading suspect

I forgot to take readings before discarding sample.

Start Time: 4:17

Dosing Table:

~~Minute~~ Time	Dosage	Total	Unit
0	1	1	Drop
0.5	1	2	Drop
6.5	1	3	Drop
7	1	4	Drop
1d:30	1	5	Drop
13	1	6	Drop
Total:			

Notes: NTU reading. 36.47

first reaction noted, waited 5 minutes for reading → 46.71

Approximately how long to get reaction?

* filter is simply a coffee filter.

* 1 drop Biostar-CH stir for 5 seconds, wait remainder of 30 seconds repeat until desired results. Take ~~Start~~ turbidity reading after 5 min after first reaction noted, add another drop to see if there is improved Turbidity reduction.

NTU reading: 31.59

Sheet 1 of 1

Test 8

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 6-1-16

Field Analyst(s): Kirby Templin, Louis Siglemeers

Site: Wenck Basement (GV)
Synthetic Surface of 1g Tad to 1000mL

Product Tested: APL Bridger (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	4:[illegible]pm	21.31	7.23	136.1	[illegible]
Final (X min after floc addition)	5:02pm	20.39	7.93	65.68	32.90

reading suspect

start time: 4:49

Dosing Table:

~~Min~~ Time	Dosage	Total	Unit
0	1	1	Drop
0.5	1	2	Drop
1	1	3	Drop
~~[illegible]~~			
7	1	4	Drop
7.5	1	5	Drop
8	1	6	Drop
Total:			

first reaction noticed, waited 5 mints for NTU reading → 70.76

Notes:

Approximately how long to get reaction?

* filtering using a coffee filter.

* 1 drop Apl Bridger stir 5 seconds wait reminder of 30 second. repeat until flocculation Noticed. wait 5 mints to take NTU reading. ~~Add 1 drop stir 5 seconds wait reminder of 30 seconds. repeat~~ until max reduction is acheived.

NTU reading 65.68

Sheet 1 of 1

Test 9

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 6-1-16

Field Analyst(s): Kirby Templin, Louis Sigfermans

Site: Wenck Basement (GV)
Synthetic sample of 12 TSS to 1000 mL

Product Tested: Biostar-CH (first) then APL Bridger (second) (Nikel & Associates)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction 750% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	5:19pm	21.31	7.23	135.3	
Final (X min after floc addition)	5:33pm	19.30	7.62	43.49	24.29

reading suspect

Product code

start time: 5:19

Dosing Table:

	Time	Dosage	Total	Unit
B	0	1	1	Drop
A	0.5	1	2	Drop
B	6	1	3	Drop
A	6.5	1	4	Drop
B	7	1	5	Drop
A	7:30	1	6	Drop
	Total:			

NTU reading 43.49

first reading taken after reaction. Detailed 5 minutes. NTU reading → 67.35

Notes:

Approximately how long to get reaction?

* filter is simply a coffee filter

* Add 1 drop Biostar and stir 5 seconds wait remainder of 30 seconds, Add 1 drop APL Bridger stir 5 seconds wait remainder of 30 seconds. Take NTU reading only after Both Biostar-CH and APL Bridger had been added And there was a reaction. repeat until stored results.

Product Code
B = Biostar-CH 1% Drop
A = APL Bridger Drop

* Call Manufacturer, is there a reason add specify and test twice versus adding together?

Sheet 1 of 1

~~Test~~ Test 10

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 6-1-16

Field Analyst(s): Kirby Templin
Louis Sigfermans

Site: Wenck Basement (GV)
Synthetic sample of 1L Tad to 1000mL

Product Tested: APL Bridger (first) then Biostar-CH (second) (Child and Associates)

Significant Reaction? Y N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% Y N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	5:48pm	21.31	7.23	157.9	[redacted]
Final (X min after floc addition)	6:07pm	19.87	7.57	48.14	22.46

reading suspect

Pulse Feeder

start time: 5:50pm

Dosing Table:

	Time	Dosage	Total	Unit
A	0	1	1	Drop
B	0.5	1	2	Drop
A	6	1	3	Drop
B	6.5	1	4	Drop
A	7	1	5	Drop
B	7.5	1	6	Drop
	Total:			

NTU reading 48.14

first reaction noticed, waited 5 minutes, NTU reading 75.97

Notes:

Approximately how long to get reaction?

* Filter is simply a coffee filter

* Add 1 drop ~~Biostar~~ APL Bridger and stir 5 seconds, wait remainder of 30 seconds, then add 1 drop Biostar CH and stir 5 seconds wait remainder of 30 seconds. Take NTU reading only after Both ~~Biostar CH~~ APL Bridger and Biostar-CH 2% have been added. Add when there was a reaction. repeat until desired results.

Product Code
B = Biostar-CH 2% Drop
A = APL Bridger Drop

* See call note on other sheet.

Sheet 1 of 1

Test 11

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 6/2/16

Field Analyst(s): Kirby Templin
Louis Sigtermans

Site: Wenck Basement (GV)

Synthetic Sample of 12 Tad to 1000mL

Product Tested: APS 7036 #3 Floc Log
(Applied Polymer Systems, Inc)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	2:22pm	21.95	7.40	116.8	[illegible]
Final (X min after floc addition)	2:56pm	21.85	7.40	23.15	10.65

Reading suspect.

Start time: 2:30pm

Dosing Table:

Time (min)	Dosage	NTU ~~Unit~~
0	1	—
5	—	45.58
10	—	36.79
Stir for	30 seconds	
15	—	26.31
20	—	23.15
Total:		

Notes:

Approximately how long to get reaction?

* Add ½ pencil size eraser piece that fits in the drop size spoon for measurement

1 minute and let stand for reaction and flocculation to occur. Take NTU reading at 5 min and 10 minute mark.

Time (Min) when reaction was noted to first occur not recorded.

Sheet 1 of 1

Test 12

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 6/2/16

Field Analyst(s): Kirby Templin [redacted] Lab Technicians

Site: Wenck Basement (GV)
Synthetic Sample of 12 Tad to 1000mL

Product Tested: APS 706b Floc log
(Applied Polymer Systems, Inc.)

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

Significant Reaction? (Y) N

reduction >50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	3:1[redacted]	21.95	7.40	150.5	[redacted]
Final (X min after floc addition)	3:34pm	20.47	7.79	15.30	11.45

reading suspect

Start time: 3:14

Dosing Table:

Time (min)	Dosage (pc)	~~Unit~~ NTU
0	1 piece	—
5	—	65.75
[redacted]		
10	—	64.35
[redacted]		
15	—	15.30
Total:		

Stir 30 seconds

Notes:

Approximately how long to get reaction?

* Add 1 pencil eraser size piece (size that would fit in drop size measuring spoon). stir for 1 minute. wait 5 minutes and take NTU reading. stir for 30 seconds and wait till 10 min and take NTU reading. repeat until desired results.

Time (min) when reaction was noted ~~date~~ to first occur 1 minute.
* noticed once stirring finished.

Sheet 1 of 1

WENCK ASSOCIATES

Responsive partner. Exceptional outcomes.

test 13

Date: 6/2/16

Site: Wenck Basement (GV)
Synthetic Sample of 12TAL to 1000mL

Field Analyst(s):
Kirby Templin
Louis Sigtermans

Product Tested: APS 703d #3 and 706b Floc log (simultaneously) (Applied Polymer Systems, Inc.)

Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking) or Slow Mix (Stirring)

reduction >50% (Y) N

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial	3:45pm	21.95	7.40	145.7	[illegible] reading suspect
Final (X min after floc addition)	4:08pm	20.46	7.62	30.82	23.26

starting time: 3:47pm

Dosing Table:

Time (min)	Dosage	~~Unit~~ NTU
0	1 piece	—
5	—	64.71
10	—	40.75
15	—	30.82
Total:		

30 sec
30 sec

Time (min) when reaction was noted to first occure 1 minute
* noticed once stirring finished.

Notes:

Approximately how long to get reaction?

* Add ± pencil eraser size piece (size that would fit in chop sticks measuring spoon.) of both packets at same time
Stir for 1 minute, wait 5 minutes and take NTU reading. Stir 30 seconds and wait another 5 minutes and take Ntu reading. repeat until desired results.

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment B

Sample 1 (From a discharge hose at a St. Croix River construction site)

Test Checklist

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4	X	Earth Poly-Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6	X	LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8	X	APL Bridger	Hild and Associates
9	X	Biostar-CH (first) then APL Bridger (second)	Hild and Associates
10	X	APL Bridger (first) then Biostar-CH (second)	Hild and Associates
11	X	APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
12	X	APS 706b Floc Log	Applied Polymer Systems, Inc.
13	X	APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Test # 1

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Control

Significant Reaction? Y (N)

Mixing Method: No Mixing Method

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Initial readings suspect, so retested with different meter and identified >1000

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial	1:09	21.30	7.46	~~154.6~~ 146.8	1:21
Final (5 min)	1:14				~~135.2~~

Notes:

* The filter used was a coffee filter.

• The control is a reference that can be used to compare the results from the products that were tested.

• There were no products tested in the control.

Test # 2

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

(Test 1) *See control Notes

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)
Initial (Control)	1:09	21.30	7.46	~~1416~~ >1000	
Final	1:41	20.10	5.69	19.57	3.463

Dosing Table:

Starting Time (clock): 1:25

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)	
0	1	1		
1	1	2		
2	1	3	30.35	(7 min)
7	1	4		
8	1	5	19.57	(13 min)

Notes:

* The filter used was a coffee filter.

Visible flocs after 3rd drop added - some floating / buoyancy neutral
After 5th drop, flocs larger, still floating flocs present
Filter clogged very quickly

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 3

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

>1000 * See cont'd (test 1) notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~191.6~~	
Final	2:02	~~20.10~~ 20.56	~~5.69~~ 7.28	28.95	20.32

Dosing Table:

Starting Time (clock): 1:46

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	
~~X~~1	1	2	
2	1	3	
3	2	5	41.45 (8 min)
8.5	2	7	28.95 (13.5 min)

Notes:

* The filter used was a coffee filter.

Flocs appeared after 5 drops
More & smaller flocs after 7 drops. Minimal floating flocs
Filter clogged moderately quickly

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 4

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Earth Poly-Stable Plus (Earth and Road)

Significant Reaction? Y (N)

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

>1000 (Test 1) * see Control Notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~154.6~~	
Final	2:24	20.48	7.11	97.63	74.51

Dosing Table:

Starting Time (clock): 2:05

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	
1	1	2	
2	1	3	
3	2	5	
4.5	1 tad	21	98.04
10.5	1 tad	37	97.63

(9.5 min) (15.5 min)] suspect readings. may not be rent.

Notes:

* The filter used was a coffee filter.

After first tad addition, sample became thick / syrupy

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 5

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

>1000 (test 1) *see control notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~154.6~~	
Final	2:51	22.10	7.26	22.34	12.28

Dosing Table:

Starting Time (clock): 2:31

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)	
0	1	1		
0.5	1	2		
1	1	3		
1.5	1	4		
2	1	5	41.85	(7 min)
7	1	6		
8	2	8	23.18	(13 min)
14	2	10	22.34	(19 min)

Notes:

* The filter used was a coffee filter.

Filter clogged fairly quickly

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 6

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Dual Part System (DPS) LB2101 and Liquifloc 1%

(Dober)

Mixing Method: Rapid Mix - LB2101 (Shaking)
Slow Mix - Liquifloc 1% (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

>1000 *See (test 1) control Notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~89.6~~	
Final	3:13	22.81	7.07	33.90	24.11

Dosing Table:

Start Time (clock): 2:54

Time (min)	Step	Pre-filter Turbidity (NTU)	
0	1		
1	2		
2	3	68.68	(7 min)
8	4	41.28	(13 min)
14	5	33.90	(19 min)

Step Table:

Step	LB2101 Added (Drops)	Liquifloc 1% Added (Drops)	Cumulative Dosage (Drops)
1	1	1	1 / 1
2	2	1	3 / 2
3	2	2	5 / 4
4	3	2	8 / 6
5	3	3	11 / 9
6	4	3	15 / 12
7	4	4	19 / 16
8	5	4	24 / 20

Cumulative Dosage: LB2101 / Liquifloc 1%

Notes:

* The filter used was a coffee filter.

Some floating flocs observed

Mixing Guidance:

• Start mixing ratio at step one which is to add 1 drop LB2101 and shake for 5 seconds and then add 1 drop Liquifloc 1% and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, perform next mixing step. If reaction is noticed, wait remainder of 5 minutes to test turbidity (Allows floc to settle). Repeat for next mixing step until desired results.

Test # 7

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

>1000 * see (test 1) control notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~154.6~~	
Final	3:36	22.89	7.25	21.69	14.38

Dosing Table:

Starting Time (clock): 3:17

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)	
0	1	1		
0.5	1	2		
1	1	3		
1.5	1	4	52.10	(6.5 min)
7	1	5		
7.5	1	6	26.76	(12.5 min)
13	2	8	21.69	(18 min)

Notes:

* The filter used was a coffee filter.

Flocs bigger after 6 drops

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 8

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

(Louis Sigtermans (Wenck))

~~Jeff Strom (Wenck)~~

Other

Product Tested: APL Bridger (Hild and Associates)

Significant Reaction? (Y) N ?

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N (only after filtering (test 1))

Sample Parameters:

>1000 *see control notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~[illegible]~~	
Final	4:13	20.80	7.38	58.92	41.31

Dosing Table:

Starting Time (clock): 3:58

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)	
0	1	1		
0.5	~~2~~ 1	2		
1	1	3		
1.5	1	4	62.99	(6.5 min)
7	1	5		
7.5	1	6		
8	1	7		
8.5	1	8	58.92	(13.5 min)

Notes:

* The filter used was a coffee filter.

Very small flocs; once settled, flocs are clumped tightly, stirring does not break them easily

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 9

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: Biostar-CH (first) then APL Bridger (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

>1000 * See (Test 1) Control note

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~DNT.6~~	
Final	4:31	23.29	7.29	20.68	11.00

Dosing Table:

Starting Time (clock): 4:17

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)		Pre-filter Turbidity (NTU)	
0	B	1	1	1		
0.5	A	1	1	2		
1	B	1	2	3		
1.5	A	1	2	4	47.19	(6.5 min)
7	B	1	3	5		
7.5	A	1	3	6		
8	B	1	4	7		
8.5	A	1	4	8	20.68	(13.5 min)

Product Code: A = APL Bridger, B = Biostar-CH 2%

Notes:

* The filter used was a coffee filter.

Mixing Guidance:

• Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 10

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: APL Bridger (first) then Biostar-CH (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

>1000 *see control notes (test 1)

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~154.6~~	
Final	4:47	23.31	7.21	23.70	9.688

Dosing Table:

Start Time (clock): 4:33

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)		Pre-filter Turbidity (NTU)	
0	A	1	1	1		
0.5	B	1	1	2		
1	A	1	2	3		
1.5	B	1	2	4	64.78	(6.5 min)
7	A	1	3	5		
7.5	B	1	3	6		
8	A	1	4	7		
8.5	B	1	4	8	23.70	(13.5 min)

Product Code: A = APL Bridger, B = Biostar-CH 2%

Notes:

* The filter used was a coffee filter.

Mixing Guidance:

• Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 11

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~
Louis Sigtermans (Wenck)
~~Jeff Strom (Wenck)~~
Other

Product Tested: APS 703d#3 Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

>1000 *see Control (Test 1) notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~154.6~~	
Final	5:16	23.19	7.21	138.4	123.4

Dosing Table:

Starting Time (clock): 4:58

Time (min)	Pre-filter Turbidity (NTU)
5	147.0
10	144.1
Stir for 30 seconds	
15	138.4

Turbidity readings suspect. may not be accurate.

Notes:

* The filter used was a coffee filter.

Log still visible after 15 min

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Test # 12

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: APS 706b Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

>1000 * See (test 1) control notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.46	~~159.6~~	
Final	5:18	23.16	7.28	139.1	121.0

Dosing Table:

Starting Time (clock): 4:58

Time (min)	Pre-filter Turbidity (NTU)
5	149.1
10	146.8
Stir for 30 seconds	
15	139.1

Turbidity reading suspect. may not be accurate.

Notes:

* The filter used was a coffee filter.

Log still visible after 15 min

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Test # 13

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 7/21/16

Site: St. Croix

Indicate Field Analyst(s):

~~Kirby Templin (Wenck)~~

Louis Sigtermans (Wenck)

~~Jeff Strom (Wenck)~~

Other

Product Tested: APS 703d#3 and APS 706b Floc Log (simultaneously)

(Applied Polymer Systems, Inc.)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? Y (N)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

>1000 *see (test 1) control notes

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	1:09	21.30	7.96	~~1514~~	
Final	5:20	23.25	7.13	123.2	103.9

Dosing Table:

Starting Time (clock): 4:58

Time (min)	Pre-filter Turbidity (NTU)
5	149.2
10	143.3
Stir for 30 seconds	
15	123.2

Turbidity readings suspect. may not be accurate.

Notes:

* The filter used was a coffee filter.

Log still visible after 15 min.

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon for both products simultaneously. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment C

Sample 2 (From a discharge hose at a Hwy 53 construction site in northern MN)

Test Checklist

Responsive partner.
Exceptional outcomes.

Date: 8/3/16

Site: 53

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Stefanich (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Rebecca F. Bob Dwayne Stenlund

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4	X	Earth Poly-Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6	X	LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8	X	APL Bridger	Hild and Associates
9	X	Biostar-CH (first) then APL Bridger (second)	Hild and Associates
10	X	APL Bridger (first) then Biostar-CH (second)	Hild and Associates
11	X	APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
12	X	APS 706b Floc Log	Applied Polymer Systems, Inc.
13	X	APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Sheets and guidance developed through field testing of products

Test # 1

Responsive partner.
Exceptional outcomes.

Date: 8/3/16

Site: 53

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: Control

~~**Significant Reaction?** Y N~~

Mixing Method: No Mixing Method

~~**Reduction to < 50 NTU?** Y N~~

*initially ready suspect so, *retested with different meter. Both read greater than >1000.

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial	8:47	22.3	7.04	[illegible]	
Final	8:58				[illegible]

Notes:

* The filter used was a coffee filter.

3:50pm *After all Test were completed, the Turbidity was remeasured at >1000

- The control is a reference that can be used to compare the results from the products that were tested.
- There were no products tested in the control.

~~1895 dilute 50% Sample 50% distilled~~

*May be red sample to get lab NTU reading and Iron reading.

Test # 2

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigfermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Duayne Sterlund
Rebecca Farmer.

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

>1000 tested multiple times and consistent

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	6.47	22.3	7.04	~~100.9~~	
Final	9:19	22.7	6.29	26.74	10.02

Dosing Table:

Starting Time (clock): 9.09

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	
0.5	1	2	174.3 ~~168.9~~
5.5	1	3	26.74

Not sure why reading higher. was definitely flocing and should be lower than initial

* retested initial with diffent Metral got >1000 as initial.

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 6.056

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #2 Sheet 1 of 1

Test # 3

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Dwayne Sterlund, Rebecca Farmer

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? Y N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:41	22.3	7.04	>1000	
Final	10:02	23.9	7.40	57.12	47.02

Dosing Table:

Starting Time (clock): 9:36

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	—
0.5	1	2	194.8
5.5	1	3	162.0
11	1	4	90.57
16.5	1	5	72.72
21	1 smidge	7 drops	57.12

Suspect readings however reaction was occurring.

Notes:

* The filter used was a coffee filter.

3:50pm * After all test were completed, The turbidity was measured at 45.61

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test #3 Sheet 1 of 1

* May want to try grinding it down to make more uniform.

Test # 4

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Dwayne Stenlund
Rebecca Dornan

Product Tested: Earth Poly-Stable Plus (Earth and Road)

Significant Reaction? Y (N)

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	10:43	24.4	7.23	180.5	180.4

Dosing Table:

Starting Time (clock): 10:12

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	194.1
5.5	1	2	184.6
12	1	3	184.4
18.5	1 Smidge	5 drop	178.9
24	1 TAD	21 drop	180.5

Turbidity readings may not be accurate. Turbidity did not appear to improve, and initial reading was >1000

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 169.9. Likely not real.

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #4 Sheet 1 of 1

Test # 5

Responsive partner.
Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Anayeli Rebecca

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	28.5	25.7	7.18	41.27	30.52

Dosing Table:

Starting Time (clock): 10:50

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	—
1.5	1	2	174.0
7	1	3	116.3
12.5	1	4	80.31
18	1	5	56.42
23.5	1	6	41.27

readings suspect lowered reaction unsuccessful

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 19.87

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #5 Sheet 1 of 1

Test # 6

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Lorie Sigermann (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: Dual Part System (DPS) LB2101 and Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix - LB2101 (Shaking)
Slow Mix - Liquifloc 1% (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	13:55	27.2	6.81	45.96	32.50

Dosing Table:

Start Time (clock): 13:28

Time (min)	Step	Pre-filter Turbidity (NTU)
0	1	no reaction
1.5	2	186.8
~~7.0~~ 7.0	3	126.1
12.5	4	62.71
~~17~~ 18.0	5	45.96

Possibly suspect bonding reaction was occurring

Step Table:

Step	LB2101 Added (Drops)	Liquifloc 1% Added (Drops)	Cumulative Dosage (Drops)
1	1	1	1 / 1
2	2	1	3 / 2
3	2	2	5 / 4
4	3	2	8 / 6
5	3	3	11 / 9
6	4	3	15 / 12
7	4	4	19 / 16
8	5	4	24 / 20

Cumulative Dosage: LB2101 / Liquifloc 1%

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 28.01

Mixing Guidance:

• Start mixing ratio at step one which is to add 1 drop LB2101 and shake for 5 seconds and then add 1 drop Liquifloc 1% and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, perform next mixing step. If reaction is noticed, wait remainder of 5 minutes to test turbidity (Allows floc to settle). Repeat for next mixing step until desired results.

Sheets and guidance developed through field testing of products

Test # 7

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigstrom (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Third~~

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	14:40	27.9	6.73	35.18	24.83

Dosing Table:

Starting Time (clock): 14:10

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	[illegible]
0.5	1	2	[illegible] 170.0
6.0	1	3	102.0
11.0	1	4	71.78
17.0	1	5	50.26
23.5	1	6	35.18

> readings suspect however reaction was OCCuring.

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 27.22

Mixing Guidance:

- Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #7 Sheet 1 of 1

Test # 8

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.) (circled)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.) (circled)

~~Other~~

Product Tested: APL Bridger (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	2:42	28.0	6.83	134.2	125.7

Dosing Table:

Starting Time (clock): 2:10

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	—
0.5	1	2	195.9
6	1	3	199.0
11.5	1	4	
12	1	5	176.7
17.5	1	6	
18	1	7	145.9
23.5	1	8	134.2

These readings may not be accurate.

*readings suspect since >100 NTU however reaction was occurring

More likely to be accurate. Floc and improved turbidity was noticed but not improved to target level.

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 119.4

Mixing Guidance:

- Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #8 Sheet 1 of 1

Test # 9

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: S3

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: Biostar-CH (first) then APL Bridger (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	15:32	28.2	6.62	31.54	21.46

Dosing Table:

Starting Time (clock): 15:03

Test

	Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
1	0	B	1	1	
	0.5	A	1	2	169.9
2	6.5	B	1	3	
	7.0	A	1	4	71.29
3	12.5	B	1	5	
	13.0	A	1	6	41.31
4	19.5	B	1	7	
	20.0	A	1	8	31.54

reading suspect, bubble machine was occurring.

Product Code: A = APL Bridger, B = Biostar-CH 2%

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 29.09

Mixing Guidance:

• Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test # 10

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: APL Bridger (first) then Biostar-CH (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	3:30	28.3	6.73	32.97	19.46

Dosing Table:

Start Time (clock): 3:01

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	A	1	1	
0.5	B	1	2	188.3
6.5	A	1	3	
7	B	1	4	111.0
12.5	A	1	5	
13	B	1	6	50.10
18.5	A	1	7	
19	B	1	8	32.97

Product Code: A = APL Bridger, B = Biostar-CH 2%

Nearly surpassed >100 NTU however reaction was accepted

Notes:

* The filter used was a coffee filter.

3:50pm * After all test were completed, the turbidity was measured at 25.49

Mixing Guidance:

• Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 11

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Duane Sterlund, Rebecca Farmer

Product Tested: APS 703d#3 Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	11:55	25.6	6.50	152.2	132.8

Dosing Table:

Starting Time (clock): 11:13

Time (min)	Pre-filter Turbidity (NTU)
5	109.9
10	131.7
Stir for 30 seconds	
15	102.6
20	207.3
Stir for 30 seconds	
25	154.4
30	152.2

109.9 ← likely not real
131.7 ← likely not real
102.6 ← likely not real
207.3 ← likely not real NTU?
likely real
* really suspect reaction was occurring

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 57.15

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Test # 12

Responsive partner. Exceptional outcomes.

Date: 8/3/16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other Dwayne Stenlund, Rebecca Forman

Product Tested: APS 706b Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	12:00 ~~11:55~~	26.1	6.81	207.4	206.0

Dosing Table:

Starting Time (clock): 11:18

Time (min)	Pre-filter Turbidity (NTU)
5	105.5 — ~~Likely~~ likely not real.
10	111.7 — likely not really
Stir for 30 seconds	
15	163.6
20	164.7
Stir for 30 seconds	
25	203.7
30	207.4

Likely ~~Post-filter~~ not real NTU.

Notes:

* The filter used was a coffee filter.

3:50p.m * After all tests were completed, the turbidity was measured at 200.5 ↑ likely not real.

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Test #12 Sheet 1 of 1

Test # 13

Responsive partner. Exceptional outcomes.

Date: 8-3-16

Site: 53

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: APS 703d#3 and APS 706b Floc Log (simultaneously)

(Applied Polymer Systems, Inc.)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? Y / N

Reduction to < 50 NTU? Y / N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	8:47	22.3	7.04	>1000	
Final	13:52	28.3	6.54	94.90	62.86

Dosing Table:

Starting Time (clock): 13:20

Time (min)	Pre-filter Turbidity (NTU)
5	149.1
10	174.3
Stir for 30 seconds	
15	192.0
20	191.5
stir for 30 seconds	
25	97.45
30	94.90

May not be real. *nodys suspect >100 NTU

real

Notes:

* The filter used was a coffee filter.

3:50pm * After all tests were completed, the turbidity was measured at 66.59.

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon for both products simultaneously. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment D

Sample 3 (From a discharge hose at a St. Paul Technical College construction site)

Test Checklist

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigmans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4	X	Earth Poly-Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6	X	LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8	X	APL Bridger	Hild and Associates
9	X	Biostar-CH (first) then APL Bridger (second)	Hild and Associates
10	X	APL Bridger (first) then Biostar-CH (second)	Hild and Associates
11	X	APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
12	X	APS 706b Floc Log	Applied Polymer Systems, Inc.
13	X	APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Sheets and guidance developed through field testing of products

Test # 1

Responsive partner.
Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigtermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: Control

Significant Reaction? Y (N)

Mixing Method: No Mixing Method

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial	8:50	21.5	8.14	>1000	
Final	8:55				>1000

Notes:

* The filter used was a coffee filter.

* There was some settling noticed after all tests were completed, however water remained still very turbid see next note.

2:25pm * After all Tests were completed, Turbidity was rechecked >1000

- The control is a reference that can be used to compare the results from the products that were tested.
- There were no products tested in the control.

Test # 2

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: ~~8/9~~ 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
Louis Sigtermans (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? Y (N)

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	9:15	22.7	5.53	71,000	71,000

Dosing Table:

Starting Time (clock): 9:00

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0:00	1	2	
0:45	1	2	
2:00	1	3	
3:00	1	4	
4:00	1	5	
5:00	1	6	
6:00	1	7	
7:00	2 (1 min. 45 sec)	9	
8:50	2 (1 min 50 sec)	11	

Time	Dose	Cum.	NTU
12:20	4	15	
14:30	16	31	>1,000

Notes:

* The filter used was a coffee filter.

NOTE: after 16 ~~drops~~ dose added (31 cumulative) noticed product was not fully dissolved

*settly took time, it was noticed while other test were performed that floc was settling.

*floc was very fine.

Mixing Guidance: *Turbidity was checked after all tests performed. 5.16 NTU after all tests performed 2:25 pm

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #2 Sheet 1 of 1

Test # 3

Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigtermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? Y (N) but reaction noted

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	10:00	23.7	7.79	399.1	391.8

Dosing Table:

Starting Time (clock): 9:28

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0:00	1	1	
1:00	1	2	
1:30	1	3	
2:15	1	4	
3:30	2	6	
4:00	2	8	
4:45	2	10	
5:45	4	14	
7:00	4	18 *	>1,000

Time	Dose	Cum.	NTU
13:30	4	22	547.8 **
19:30	4	26	592.0
26:00	4	30	399.1

Notes:

* The filter used was a coffee filter.

* floc started forming - water column still very turbid (18)

** at cumulative ⑧ of 22, began noticing that floc was not fully dissolving

* floc settled and was noticeable on bottom however water column was still turbid.

2:25pm * After all tests - Turbidity was remeasured. 377.7

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test #3 Sheet 1 of 1

Test # 4

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
Louis Sigtermans (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other

Product Tested: Earth Poly-Stable Plus (Earth and Road)

Significant Reaction? Y (N) reaction occurred, not significant

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	10:30	23.3	7.85	—	—

see notes below

Dosing Table:

Starting Time (clock): 10:17

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0.00	1	1	no reaction
0:30	1	2	627.2 *reaction noted
6:15	1	3	587.6 **gelatin started to form
13:00	1	4	did not test *** similar to previous

Notes:

* The filter used was a coffee filter.

* reaction noted floc settled well
** floc did not settle well, gelation started to form
*** formed a thick gel substance did not test for turbidity -- appox same as previous dose

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

* floc settled and was noticeable on bottom, however water column was still turbid.
* the water texture was thick and jelly like...

2:25pm * After all test turbidity was added and was measured at 635.6

Test # 5

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
Louis Sigtermans (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	11:45	25.8	7.45	80.12	100.5

Dosing Table:

Starting Time (clock): 10:55

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)	
0:00	1	1		no reaction
1:15	1	2		no reaction
2:30	1	3		no reaction
3:30	1	4		no reaction
4:30	1	5		no reaction
5:30	3	8		no reaction
7:00	3	11		no reaction
8:15	3	14		no reaction
9:15	3	17		slight reaction noted

Notes:

* The filter used was a coffee filter.

Time	Dose	Cum.	NTU	
10:45	3	20	71,000	slight reaction
16:00	3	23	71,000	slight reaction
21:30	3	26	805.7	
28:30	3	29	432.0	
34:00	3	32	508.4	
38:30	3	35	125.9	
44:00	3	38	80.12	

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

* floc seattled at was noticeable on bottom.
2:45pm * After all test performed the bridge was removed 38.16

Test # 6

Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: Dual Part System (DPS) LB2101 and Liquifloc 1% (Dober)

Mixing Method: Rapid Mix - LB2101 (Shaking)
Slow Mix - Liquifloc 1% (Stirring)

Significant Reaction? Y (N)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	2:15	27.9	7.24	>1000	>1000

Dosing Table:

Start Time (clock): 13:45

Time (min)	Step	Pre-filter Turbidity (NTU)
0:00	1	no reaction
1:30	2	no reaction
3:00	3	no reaction
4:45	4	no reaction
6:15	5	no reaction
7:45	6	no reaction
9:15	7	no reaction
11:15	8	no reaction
12:15	9	no reaction
13:15	10	no reaction
14:30	11	>1000
20:00	12	>1000

Step Table:

Step	LB2101 Added (Drops)	Liquifloc 1% Added (Drops)	Cumulative Dosage (Drops)
1	1	1	1 / 1
2	2	1	3 / 2
3	2	2	5 / 4
4	3	2	8 / 6
5	3	3	11 / 9
6	4	3	15 / 12
7	4	4	19 / 16
8	5	4	24 / 20
9	5	5	29 / 25
10	6	5	35 / 30
11	6	6	41 / 36
12	7	6	48 / 42
13	7	7	55 / 49

Cumulative Dosage: LB2101 / Liquifloc 1%

Notes:

* The filter used was a coffee filter.

*Floc was noticed accumulated on bottom of jar, however water column was still very turbid - see Final and End readings

Mixing Guidance: *

- Start mixing ratio at step one which is to add 1 drop LB2101 and shake for 5 seconds and then add 1 drop Liquifloc 1% and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, perform next mixing step. If reaction is noticed, wait remainder of 5 minutes to test turbidity (Allows floc to settle). Repeat for next mixing step until desired results.

2:25pm * After all tests performed turbidity was remeasured >1000

Sheets and guidance developed through field testing of products

Test #6 Sheet 1 of 1

Test # 7

Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):

(Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

(Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? Y (N)

*There was a reaction, Not significant.

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	10:19	22.7	7.73	763.5	760.2

Dosing Table:

Starting Time (clock): 9:57

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	
0.5	1	2	
1	1	3	
1.5	1	4	
2	1	5	
2.5	1	6	
3	1	7	
3.5	1	8	

Time	dose (drop)	cumulative dose (drops)	NTU
4	1	9	
4.5	1	10	
5	1	11	
5.5	3	14	
6	3	17	
6.5	3	20	
7	3	23	
floc occurred → 12.5	3	26	>1000
floc occurred → 13.0	3	29	763.5

Notes:

* The filter used was a coffee filter.

* fine floc was noticed to settle on bottom, however water column was still turbid.

2:25pm * After all tests completed turbidity was remeasured at 612.4

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #7 Sheet 1 of 1

Test # 8

Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigfermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: APL Bridger (Hild and Associates)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	10:48	24.5	8.00	>1000	>1000

Dosing Table:

Starting Time (clock): 10:26

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	
0.5	1	2	
1	1	3	
1.5	1	4	
2	1	5	
2.5	1	6	
3	1	7	
3.5	1	8	

slight flocing →

Time	Dose (Drops)	Cumulative Dose (Drop)	NTU
4	3	12	
4.5	3	15	
5	3	18	
5.5	3	21	
6	3	24	
6.5	3	27	>1000
4.5	3	30	
13	3	33	>1000

Notes:

* The filter used was a coffee filter.

* Some settly floc noted on bottom however water column is still very turbid.

2:25pm * After all samples completed turbidity was remeasured at >1000.

Mixing Guidance:

- Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test # 9

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
~~Louis Sigtermans~~ (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other

Product Tested: Biostar-CH (first) then APL Bridger (second)
(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? Y (N)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	11:40	24.8	7.75	573.7	549.8

Dosing Table:

Starting Time (clock): 11:10

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	B	1	1	
0.5	A	1	2	
1	B	1	3	
1.5	A	1	4	
2	B	2	6	
2.5	A	2	8	
3	B	2	10	
3.5	A	2	12	

NTU
>1000
689.7
573.7

Time	Code	Dose	Cum Dose
4	B	2	14
4.5	A	2	16
5	B	3	19
6	A	3	22
6.5	B	3	25
7	A	3	28
14	B	3	31
14.5	A	3	34
21	B	3	37
21.5	A	3	40

Product Code: A = APL Bridger, B = Biostar-CH 2%

Notes:

* The filter used was a coffee filter.

* some settling/floc noticed on bottom. However water column was still very turbid
1:25pm * After all test were completed, turbidity was remeasured at 486.8.

Mixing Guidance:

• Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test # 10

Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):

(Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans~~ (Wenck Associates, Inc.)

(Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: APL Bridger (first) then Biostar-CH (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? Y N

Reduction to < 50 NTU? Y N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	12:14	29.1	7.43	233.4	—

* forgot to test.

Dosing Table:

Start Time (clock): 11:46

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	A	3	3	
0.5	B	3	6	
1	A	3	9	
1.5	B	3	12	
2	A	3	15	
2.5	B	3	18	
3	A	3	21	
3.5	B	3	24	

Product Code: A = APL Bridger, B = Biostar-CH 2%

Time	Product	Dose	cum Dose	NTU
4	A	3	27	
4.5	B	3	30	
5	A	3	33	
5.5	B	3	36	763.8
11	A	3	39	
11.5	B	3	42	453.8
18	A	3	45	
18.5	B	3	48	233.4

Notes:

* The filter used was a coffee filter.

* floc settled and noticeable on bottom.

2:25pm * After all tests complete, turbidity was remeasured at 50.16

Mixing Guidance:

• Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 11

Responsive partner.
Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigterman3 (Wenck Associates~~, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: APS 703d#3 Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	9:33	22.6	7.78	>1000	>1000

Dosing Table:

Starting Time (clock): 9:08

Time (min)	Pre-filter Turbidity (NTU)
5	>1000
10	>1000
Stir for 30 seconds	
15	>1000
20	>1000
	stir 30 seconds
25	>1000
30	>1000

Notes:

* The filter used was a coffee filter.

* Some settling/floc noticeable on bottom, however water column is still turbid.

2:25pm * After all tests performed, turbidity was remeasured. at 757.2

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Test #11 Sheet 1 of 1

Test # 12

Responsive partner.
Exceptional outcomes.

Date: 8/10/16

Site: St. Paul college

Indicate Field Analyst(s):

- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigtermans (Wenck Associates, Inc.)~~
- Jeff Strom (Wenck Associates, Inc.)
- Other

Product Tested: APS 706b Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	9:35	22.5	7.78	>1000	>1000

Dosing Table:

Starting Time (clock): 9:~~00~~04

Time (min)	Pre-filter Turbidity (NTU)
5	>1000
10	>1000
Stir for 30 seconds	
15	>1000
20	>1000
	stir 30 seconds
25	>1000
30	>1000

Notes:

* The filter used was a coffee filter.

* Some settling noticeable, however water column is till very turbid.

2:25pm * After all tests performed, turbidity was remeasured at >1000

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Test #12 Sheet 1 of 1

Test # 13

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/10/16

Site: St. Paul College

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
Louis Sigtermans (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other

Product Tested: APS 703d#3 and APS 706b Floc Log (simultaneously)
(Applied Polymer Systems, Inc.)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? Y (N)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	9:37	22.6	7.59	>1000	>1000

Dosing Table:

Starting Time (clock): 9:05

Time (min)	Pre-filter Turbidity (NTU)
5	>1000
10	>1000
Stir for 30 seconds	
15	>1000
20	>1000
	Stir 30 seconds.
25	>1000
30	>1000

Notes:

* The filter used was a coffee filter.

* Some settling/floc noticeable, however turbidity was measured at 2:25pm
* After all tests completed, turbidity was remeasured at 797.7

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon for both products simultaneously. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment E

Sample 4 (Created from a soil sample and water collected at a Hwy 371 construction site in central MN)

Test Checklist

Responsive partner.
Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigtermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4	X	Earth Poly-Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6	X	LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8	X	APL Bridger	Hild and Associates
9	X	Biostar-CH (first) then APL Bridger (second)	Hild and Associates
10	X	APL Bridger (first) then Biostar-CH (second)	Hild and Associates
11	X	APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
12	X	APS 706b Floc Log	Applied Polymer Systems, Inc.
13	X	APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Sheets and guidance developed through field testing of products

Test # 1

Responsive partner.
Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigtermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: Control

Significant Reaction? Y N

Mixing Method: No Mixing Method

Reduction to < 50 NTU? Y N

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial	9:20	21.1	6.66	507.9	
Final	9:25				496.6

Notes:

* The filter used was a coffee filter.

3:05 pm * After all tests completed, Turbidity was remeasured at 443.4

- The control is a reference that can be used to compare the results from the products that were tested.
- There were no products tested in the control.

Test # 2

Responsive partner. Exceptional outcomes.

Date: 8/11/11

Site: 371 (synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:00	21.1	6.66	507.9	
Final	9:50	21.6	3.91 low pH	44.20	11.15

Dosing Table:

Starting Time (clock): 9:30

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0:00	1	1	no reaction
1:00	1	2	no reaction
2:30	1	3	no reaction
4:00	1	4	no reaction
5:30	1	5 *	106.7
11:15	1	6	41.24
16:30	1	7	44.20

Notes:

* The filter used was a coffee filter.

noticed on drops 1-4 product not fully dissolved

* Note on drop 5 reaction occurred, but floc settling on top

3:05 pm * After all tests completed, Turbidity was remeasured at 11.75

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #2 Sheet 1 of 1

Test # 3

Responsive partner.
Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	10:42	22.1	7.35	146.5	114.9

Dosing Table:

Starting Time (clock): 10:07

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0:00	2	2	no reaction
0:45	1	3	no reaction
2:00	1	4	no reaction
3:15	1	5	262.5 slight reaction
8:45	1	6	202.5
13:45	1	7	170.6
19:15	1	8	153.7
24:00	1	9	144.1
29:16	1	10	146.5

Notes:

* The filter used was a coffee filter.

& floc settling on bottom for most part

3:05pm * After all tests were ~~completed~~, turbidity was remeasured at 111.3

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test #3 Sheet 1 of 1

Test # 4

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans~~ (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

~~Other~~

Product Tested: Earth Poly-Stable Plus (Earth and Road)

Significant Reaction? Y (N)

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	11:20	22.6	6.85	492.9	454.5

Dosing Table:

Starting Time (clock): 10:58

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0:00	1	1	no reaction
0:90	1	2	no reaction
2:00	1	3	no reaction
3:10	1	4	no reaction
4:15	1	5	no reaction
5:15	1	6	no reaction
6:15	1	7	no reaction
7:00	1	8	no reaction
8:00	1	9	no reaction

Time	Dose	Cum.	NTU
9:15	2	11	no reaction
10:15	2	13	no reaction
11:30	2	15	no reaction
12:30	2	17	no reaction
13:30	2	19	no reaction
15:00	16	35	492.9

Notes:

* The filter used was a coffee filter.

* product not fully dissolving after approx 8 drops
* gel started to form around cap at drop 8-9

3:05pm * After all tests were completed, turbidity was remeasured at 552.9

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #4 Sheet 1 of 1

Test # 5

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 731 (synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other JOEL TOSO

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	1:43pm	~~24.4°C~~ 23.8	~~6.7~~ 6.1	49	35

Dosing Table:

Starting Time (clock): 1:09pm

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	
1	1	2	
2	2	4	
3	1	5	
4	2	7	
5	2	9	
6	2	11	
7	2	13	
8	3	16	
9	3	19	25 reaction
15	3	22	133
21	6	28	93
27	6	34	49

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests were measured, turbidity was remeasured at 21.93

Mixing Guidance:

- Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #5 Sheet 1 of 1

Test # 6

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 (synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Joel Toso

Product Tested: Dual Part System (DPS) LB2101 and Liquifloc 1% (Dober)

Significant Reaction? Y / N

Mixing Method: Rapid Mix - LB2101 (Shaking)
Slow Mix - Liquifloc 1% (Stirring)

Reduction to < 50 NTU? Y / N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507	
Final	2:41	25.2	4.7	~~89~~ 102	84

Dosing Table:

Start Time (clock): 1:54pm

Time (min)	Step	Pre-filter Turbidity (NTU)
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	372
~~16~~	~~9~~	~~288~~
27	10	177
33	11	152
39.5	12	102

Step Table:

Step	LB2101 Added (Drops)	Liquifloc 1% Added (Drops)	Cumulative Dosage (Drops)
1	1	1	1 / 1
2	2	1	3 / 2
3	2	2	5 / 4
4	3	2	8 / 6
5	3	3	11 / 9
6	4	3	15 / 12
7	4	4	19 / 16
8	5	4	24 / 20
9	5	5	29 / 25
10	6	5	35 / 30
11	6	6	41 / 36
12	7	6	48 / 42

Cumulative Dosage: LB2101 / Liquifloc 1%

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests completed, turbidity was remeasured at 91.52

Mixing Guidance:

• Start mixing ratio at step one which is to add 1 drop LB2101 and shake for 5 seconds and then add 1 drop Liquifloc 1% and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, perform next mixing step. If reaction is noticed, wait remainder of 5 minutes to test turbidity (Allows floc to settle). Repeat for next mixing step until desired results.

Test # 7

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigtermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	11:18	22.5	6.01	31.36	11.31

Dosing Table:

Starting Time (clock): 10:53

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	
0.5	1	2	
1	1	3	
1.5	1	4	
2	1	5	
2.5	1	6	
3	1	7	
3.5	1	8	

Time	Dose	Cum Dose	NTU
4	2	10	
4.5	3	13	
5	3	16	
5.5	3	19	132.7
11.5	3	22	53.82
18	3	25	31.36

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests completed, turbidity was remeasured at 8.38

Mixing Guidance:

- Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #7 Sheet 1 of 1

Test # 8

Responsive partner.
Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Indicate Field Analyst(s):

~~Kirby Templin (Wenck Associates, Inc.)~~

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other

Product Tested: APL Bridger (Hild and Associates)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	11:56	23.0	6.42	338.3	150.8

Dosing Table:

Starting Time (clock): 11:29

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	
0.5	1	2	
1	1	3	
1.5	1	4	
2	1	5	
2.5	1	6	
3	1	7	
3.5	1	8	

Time	Dose	Cum Dose	NTU
4	3	11	
4.5	3	14	
5	3	17	
5.5	3	20	
6	3	23	
7.5	3	26	
8	3	29	
8.5	3	32	
9	3	35	366.0
15	3	38	
19.5	3	41	338.3

Notes:

* The filter used was a coffee filter.

3:05 pm * After all tests were completed, turbidity was remeasured at 22.75

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #8 Sheet 1 of 1

Test # 9

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 (synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigfermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Joel Toso

Product Tested: Biostar-CH (first) then APL Bridger (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	1:54	24.3	6.16	33.36	21.12

Dosing Table:

Starting Time (clock): 1:09

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	B	1	1	
0.5	A	1	2	
1	B	2	4	
1.5	A	2	6	
2	B	2	8	
2.5	A	2	10	
3	B	2	12	
3.5	A	2	14	

Product Code: A = APL Bridger, B = Biostar-CH 2%

Time	B/A	Dose	cum Dose	Ntu
4	B	2	16	
4.5	A	2	18	260.7
[illegible]	B	3	21	[illegible]
[illegible]	A	3	24	205.0
15.5	B	3	27	
16	A	3	30	119.6
22	B	5	35	
22.5	A	5	40	74.5
28	B	5	45	
28.5	A	5	50	55.06
35	B	5	55	
35.5	A	5	60	33.36

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests were completed, turbidity was remeasured at 20.76

Mixing Guidance:

• Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 10

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 (synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Jodi + OSO

Product Tested: APL Bridger (first) then Biostar-CH (second)

(Hild and Associates)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? (Y) N

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:30	21.1	6.66	507.9	
Final	1:41	25.0	6.57	40.68	22.81

Dosing Table:

Start Time (clock): 2:02

Time (min)	Product Code (A or B)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	A	3	3	
0.5	B	3	6	
1	A	3	9	
1.5	B	3	12	
2	A	3	15	
2.5	B	3	18	
3	A	3	21	
3.5	B	3	24	219.6

Product Code: A = APL Bridger, B = Biostar-CH 2%

Time	Prod	Dose	cum dose	NTU
T0	A	5	29	
10.5	B	5	34	149.9
16.5	A	5	39	
17	B	5	44	94.51
22.5	A	5	49	
23	B	5	54	60.11
29.5	A	5	59	
30	B	5	64	40.69

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests were completed, turbidity was remeasured at 31.68

Mixing Guidance:

• Add 1 drop APL Bridger and stir for 5 seconds. Let sit to react for remainder of 30 seconds. Add 1 drop Biostar-CH and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat. ONLY TAKE TURBIDITY READING IF BOTH BIOSTAR-CH AND APL BRIDGER HAVE BEEN ADDED, AND IF THERE IS A REACTION. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 11

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 Synthetic

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

Louis Sigtermans (Wenck Associates, Inc.)

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: APS 703d#3 Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	10:33	21.9	5.95	474.9	412.3

Dosing Table:

Starting Time (clock): 9:55

Time (min)	Pre-filter Turbidity (NTU)
5	467.8
10	473.2
Stir for 30 seconds	
15	500.7
20	485.8
	Stir 30 seconds
25	490.8
30	474.9

Notes:

* The filter used was a coffee filter.

3:05pm *After all tests were completed, turbidity was measured at 323.7

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Test #11 Sheet 1 of 1

Test # 12

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 Synthetic

Indicate Field Analyst(s):

- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigtermans (Wenck Associates, Inc.)~~
- Jeff Strom (Wenck Associates, Inc.)
- Other

Product Tested: APS 706b Floc Log (Applied Polymer Systems, Inc.)

Significant Reaction? Y (N)

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	10:35	21.9	6.04	372.6	337.4

Dosing Table:

Starting Time (clock): 9:57

Time (min)	Pre-filter Turbidity (NTU)
5	479.6
10	490.8
Stir for 30 seconds	
15	467.2
20	478.7
Stir for 30 seconds	
25	400.7
30	372.6

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests were completed, turbidity was measured at 277.9

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Sheets and guidance developed through field testing of products

Test #12 Sheet 1 of 1

Test # 13

Responsive partner. Exceptional outcomes.

Date: 8/11/16

Site: 371 (Synthetic)

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

Jeff Strom (Wenck Associates, Inc.)

Other

Product Tested: APS 703d#3 and APS 706b Floc Log (simultaneously)

(Applied Polymer Systems, Inc.)

Mixing Method: Slow Mix (Stirring)

Significant Reaction? Y (N)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	9:20	21.1	6.66	507.9	
Final	10:37	21.8	5.90	395.1	335.8

Dosing Table:

Starting Time (clock): 9:59

Time (min)	Pre-filter Turbidity (NTU)
5	501.9
10	497.9
Stir for 30 seconds	
15	488.8
20	470.1
Stir for 30 seconds	
25	418.5
30	395.1

Notes:

* The filter used was a coffee filter.

3:05pm * After all tests completed, turbidity was remeasured at 258.4

Mixing Guidance:

• Add 1/2 pencil size eraser piece that fits in a drop size measurement spoon for both products simultaneously. Stir for 1 minute and let sit for remainder of 5 minutes. Test turbidity at the 5 minute and 10 minute times. Stir for 30 seconds after 10 minute time. Test turbidity at the 15 minute time.

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment F

Sample 5 (Grab samples from three separate BMPs from a Hwy 36 and Lex. Ave. construction site in Roseville)

Test Checklist

Responsive partner. Exceptional outcomes.

Date: 8/12/16

Site: Hwy 36 LEX Oscar

Field ~~Analyst(s)~~:
Kirby Templin (Wenck Associates, Inc.)
~~Louis Sigfermans (Wenck Associates, Inc.)~~
~~Jeff Strom (Wenck Associates, Inc.)~~
Other Joel Foss

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4		Earth Poly-Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6		LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8		APL Bridger	Hild and Associates
9		Biostar-CH (first) then APL Bridger (second)	Hild and Associates
10		APL Bridger (first) then Biostar-CH (second)	Hild and Associates
11		APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
12		APS 706b Floc Log	Applied Polymer Systems, Inc.
13		APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Floc (Innovative Turf Solutions Inc)
Density 89.3 lb/c.f. Specific Gravity 2.65

H_2O (water)
Density 1000 kg/m³ 62.4 lbs/cf Specific Gravity 1

Standard Contracting (SCI-CW-A0)
Specific Gravity 2.65.

Liquifloc 1%
Density 1-1.1 g/mL ~62.4 lbs/cf.

Biostar CH 2% 1-1.156 ~62.4 lbs/cf

Test # 1

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/12/16

Site: Hwy 36 LEX Oscar

Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
Louis Sigternans (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other Joel Foso

Product Tested: Control

Significant Reaction? Y N

Mixing Method: No Mixing Method

Reduction to < 50 NTU? Y N

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
1st sample Initial	10:12 am	25.1	8.0	>1000	
Final					
2nd sample	11:40	26.9	7.46	282.8	
3rd sample	12:45	29.2	7.49	102.5	

Notes:

* The filter used was a coffee filter.

- The control is a reference that can be used to compare the results from the products that were tested.
- There were no products tested in the control.

Test # 2

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/12/14

Site: Hwy 36 & Lex Oscar

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans~~ (Wenck Associates, Inc.)

~~Jeff Strom~~ (Wenck Associates, Inc.)

Other Joel Toso

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	10:12am	25.1	8.00	>1000	
Final	10:48	28.1	6.31	104	34

1st test

Dosing Table:

Starting Time (clock): 10:12

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0.	1	1	
0.5	1	2	364
6.5	1	3	260
12	1	4	226
17.5	1	5	171
23	4	9	99
28.5	4	13	104

1st test

11:49 2nd Sample. (different pool)

Time	Dose	cumdos
0	1	1
1	1	2
2	1	3
3	1	4
7	2	6
14	2	8

Finally Flocced.

Notes:

* The filter used was a coffee filter.

With 2nd sample dosage & (different pool)

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #2 Sheet 1 of 1

Test # 3

Responsive partner. Exceptional outcomes.

Date: 8/12/16

Site: Hwy 36 & Lex Oscar

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (~~Wenck Associates, Inc.)

~~Jeff Strom (Wenck Associates, Inc.~~)

Other JOEL TOSO

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	10:12	25.1	8.00	>1000	
Final	10:45	27.6	7.94	38.6	26

1st test

Dosing Table:

Starting Time (clock): 10:15

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	
0.5	1	2	501
6.5	1	3	123
12	1	4	91
17.5	4	8	51.8
23.5	4	12	39.6

1st test

11:47 (different pond see test 1 for initial)

2nd Sample -

Time	Dose	Cum Dose
0	2	2
~~0.5~~		
1	2	4
~~3.5~~		
4	2	6
15	2	8
17	8	16

Notes:

* The filter used was a coffee filter.

12:50 3rd Sample total

Dose 8 8

Dosage 8 16

(Different pond) See test 1 for initial.

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test #3 Sheet 1 of 1

Test # 5

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 8/12/16

Site: Hwy 36 CEX Oscar

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
~~Louis Siefermann (Wenck Associates, Inc.)~~
~~Jeff Strom (Wenck Associates, Inc.)~~
Other Joel Toso
Duayne Stenlund.

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	10:12am	25.1	8.00	>1000	
Final	11:19	28.9	7.87	40.46	34.24

test 1

Dosing Table:

Starting Time (clock): 11:00

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	2	2	140.0
5.5	2	4	57.66
11	2	6	40.46

test 1

12:06 (different pad) see test 1 for initial dose

Time	Dose	Cumulative Dosage
0	5	5
1.5	1	6
2	2	8
5	2	10
10.5	5	15

Notes:

* The filter used was a coffee filter.

test 1 Sample 3
Dosage 15
Dosage 5
(Different pad) 20 see test 1 for initial

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #5 Sheet 1 of 1

Test # 7

Responsive partner.
Exceptional outcomes.

Date: 8/12/16

Site: Hwy 36 LEX OSCAR

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
~~Louie Sigfermans (Wenck Associates, Inc.)~~
~~Jeff Strom (Wenck Associates, Inc.)~~
Other Joel Toso
DWayne Sterlund

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	10:12	25.1	8.00	>1000	
test 1 Final	11:22	29.6	7.87	40.57	30.24

Dosing Table:

Starting Time (clock): 11:0[illegible]

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	2	2	120.1
7.5	2	4	58.12
13	2	6	40.57

test 1

Sample 2 (different pond see test 1 for initial)

Time	Dose	Cum Dose
0	5	5
1.5	3	8
4.5	2	10
9.5	5	15
20	5	20

Placed well

Notes:

* The filter used was a coffee filter.

Sample 3
12:52 Dosage 15
(different pond) Dosage 5
see test 1 for initial 20

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #7 Sheet 1 of 1

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment G

Sample 6 (Runoff grab sample from a Hwy 96 construction site in the north metro)

Test Checklist

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 9-6-16

Site: Birch Lake site Hwy 96 + White Bear Ave / Side

Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
Louis Sigtermans (Wenck Associates, Inc.)
Jeff Strom (Wenck Associates, Inc.)
Other Dwayne Stenlund

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
4		Earth Poly-Stable Plus	Earth and Road
5	X	Liquifloc 1%	Dober
6		LB2101 (first) then Liquifloc 1% (second)	Dober
7	X	Biostar-CH 2%	Hild and Associates
8		APL Bridger	Hild and Associates
9		Biostar-CH (first) then APL Bridger (second)	Hild and Associates
10		APL Bridger (first) then Biostar-CH (second)	Hild and Associates
11		APS 703d#3 Floc Log	Applied Polymer Systems, Inc.
12		APS 706b Floc Log	Applied Polymer Systems, Inc.
13		APS 703d#3 Floc Log and 706b Floc Log (simultaneously)	Applied Polymer Systems, Inc.

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232

Sheets and guidance developed through field testing of products

Test # 1

Responsive partner.
Exceptional outcomes.

Date: 9-6-16

Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
~~Louis Sigtermans (Wenck Associates, Inc.)~~
Jeff Strom (Wenck Associates, Inc.)
Other Duayne Stenlund

Site: Birch Lake site Hwy 96 Lewis Bear Arrow weir side

Product Tested: Control

Significant Reaction? Y N

Mixing Method: No Mixing Method

Reduction to < 50 NTU? Y N

Sample Parameters:

517.8

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial	11:50am	16.09	8.29		
Final					

Notes:

* The filter used was a coffee filter.

• The control is a reference that can be used to compare the results from the products that were tested.

• There were no products tested in the control.

* collected right from Leaky discharge hose
NTU 676-7
*This is from bottom of pond where we sampled from surface of pond. Not a big difference.

Test # 2

Responsive partner. Exceptional outcomes.

Date: 9-6-16

Site: Birch Lake site Hwy 96 + white Bear Avenue wet side

Indicate Field Analyst(s):
- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigbarmans (Wenck Associates, Inc.)~~
- Jeff Strom (Wenck Associates, Inc.)
- Other Dwayne Stenlund

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	11:50 am	16.09	8.29	517.8	
Final	1:10	15.86	8.26	103.0	fayot to test

rapid test final.

Dosing Table:

Starting Time (clock): 12:00 pm

conductivity 533

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1 TAd		103.0 wasted
0	4	4	195.4
	1	5	18.65

Big Dose to get turbidity.

New test 12:52

NS min 36.40 reaction

looks real clean.

Post Filter NTU 10.91

Dosage Measurement test.

Time	2:10
Temp	24.81
PH	6.63
conductivity	271.5

final Dosage measurement test final.

Notes:

* The filter used was a coffee filter.

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #2 Sheet 1 of 1

Test # 3

Responsive partner. Exceptional outcomes.

Date: 9-6-16

Site: Birch lake site Hwy 96 & White Bear Ave. weir side

Indicate Field Analyst(s):

- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigstrunds (Wenck Associates, Inc.)~~
- Jeff Strom (Wenck Associates, Inc.)
- Other Dwayne Sterlund

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	11:50	16.09	8.29	517.8	
Final		16.40	7.99	172.1	104.[illegible]

Rapid test final results. conductivity 349.5

Dosing Table:

Starting Time (clock): 12:00 pm

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
	1 Tad	1 Tad	did not measure
	1 Tad	2 Tad	99.79
	1 Tad	3 Tad	121.0
	1 Tad	4 Tad	172.1
12:52pm	1 drop	1 drop	no reaction
	1 drop	2 drop	
	1 drop	3 drops	
	1 drop	4 drops	111.8
	1 drop	5 drops	104.3
	1 drop	6 drops	97.31
	2 drops	8 drops	70.85
	2 drops	10 drops	63.54
	2 drops	12 drops	48.43
			28.67

Rapid test. Since 1 test Dosage measurement test

new sample test

Time: 2:09pm
Temp 24.93
pH 8.10
conductivity 234.2

with filter

Notes:

* The filter used was a coffee filter.

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test #3 Sheet 1 of 1

Test # 5

Responsive partner. Exceptional outcomes.

Date: 9-6-16

Indicate Field Analyst(s):
Kirby Templin (Wenck Associates, Inc.)
~~Louis Sigtermans (Wenck Associates, Inc.)~~
Jeff Strom (Wenck Associates, Inc.)
Other Dwayne Sterlund

Site: Beach lake side. Hwy 96 & white bear Ave. Weirside

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y N
After filtration

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	11:50am	16.09	8.29	517.8	
Final	rapid test final →	16.47	7.43	73.97	42.3

conductivity 251.5

Dosing Table:

Starting Time (clock): 12:13

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	15 drops	15 drops	100.2
	15 drops	30 drops	73.97
0	2 drops	2	
	2 drops	4	
	2	6	213.1
	2	8	189.0
	4	12	101.8
	4	16	71.89
	4	20	59.76

reaction → likely could be filtered to <50 NTU - Because flocking particles

Final Dosage measurement

Notes: → Filtered is 40.16

* The filter used was a coffee filter.

Time: 2:00pm
Temp 24.9
PH 7.89
Conductivity 220.6

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #5 Sheet 1 of 1

Test # 7

Responsive partner. Exceptional outcomes.

Date: 9-6-16

Site: Birch lake site weir side Hwy 96 & White Bear Avenue

Indicate Field Analyst(s):
- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigstrom (Wenck Associates, Inc.)~~
- Jeff Strom (Wenck Associates, Inc.)
- Other Dwayne Sterland

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)	11:50 am	16.09	8.29	517.8	
Final	12:41	16.04	7.33	82.00	30.95

rapid test final → conductivity 263.7

Dosing Table:

Starting Time (clock): 12:13

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
rapid test	15 drop	15 drops	89.88
	15 drop	30 drop	41.24
	15 drop	45 drop	82.00
product change 03:25			new Test
final Dosage measurement test	2 drop	2 drops	10 reaction
	2 drop	4 drops	238.4
	2 drop	6 drops	166.5
	4 drops	10 drops	93.77
	4 drops	14 drops	180.5 unfiltered 77.60 filtered
	6 drops	20 drops	46.52 unfiltered 24.42 filtered

Notes:

* The filter used was a coffee filter.

Time 2:00pm
Temp 25.01
pH 7.66
Conductivity 322.6

Mixing Guidance:

- Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Sheets and guidance developed through field testing of products

Test #7 Sheet 1 of 1

Dwayne Stenlund and Bruce Holdhusen
Minnesota Department of Transportation
March 3, 2017

WENCK ASSOCIATES
Responsive partner.
Exceptional outcomes.

Attachment H

Sample 7 (Synthetic sample made from a Nemadji River construction site soil and distilled water)

Test Checklist

Responsive partner.
Exceptional outcomes.

Date: 10-31-16

Site: Nemadji Area (Knowlton Creek)
(Synthetic Sample with soil sample and Distilled water)

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

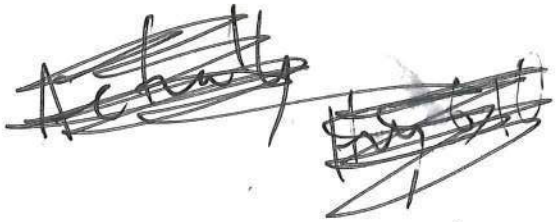
~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Rebecca Forman

Product Test List			
Test #	**Test Completed**	**Product Name**	**Manufacturer**
1	X	Control	-
2	X	Floc 06	Innovative Turf Solutions
3	X	SCI-CW-A0	Standard Contracting
5	X	Liquifloc 1%	Dober
7	X	Biostar-CH 2%	Hild and Associates

Measurement Spoon	Equivalent Measurement	Volume Equivalent (fl oz)	Volume Equivalent (mL)
Drop	1/64 Teaspoon (1/2 Smidgen)	0.002604	0.07701
Smidgen	1/32 Teaspoon (1/2 Pinch)	0.005208	0.1540
Pinch	1/16 Teaspoon (1/2 Dash)	0.01042	0.3081
Dash	1/8 Teaspoon (1/2 Tad)	0.02083	0.6161
Tad	1/4 Teaspoon	0.04167	1.232



Test # 1

Responsive partner.
Exceptional outcomes.

Date: 10-31-16

Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Rebecca Forman

Site: Nemadji Area (known Iron Creek) (synthetic Sample with soil sample at Distilled water)

Product Tested: Control

Significant Reaction? Y N

Mixing Method: No Mixing Method

Reduction to < 50 NTU? Y N

Sample Parameters:

Reading	Time	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial	10:30 am	10.8	9.58	> 1000	
Final					

Notes:

* The filter used was a coffee filter.

*Duayne Collected discharge sample in water bottle to compare Synthetic Sample Turbidity too. NTU from sample is >1000 NTU

- The control is a reference that can be used to compare the results from the products that were tested.
- There were no products tested in the control.

Test # 2

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 10-31-16

Site: Nemadji Area (knowlton Creek) (synthetic Sample with soil sample but distilled water)

Indicate Field Analyst(s):
- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigtermans (Wenck Associates, Inc.)~~
- ~~Jeff Strom (Wenck Associates, Inc.)~~
- Other Rebecca Formen

Product Tested: Floc 06 (Innovative Turf Solutions)

Significant Reaction? Y N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y N

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	1:05	13.2	7.61	45.43	16.87

Dosing Table:

3:40pm 19.14 NTU

Starting Time (clock):

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	1	1	>1000
1	1	2	350.1
7.5	1	3	125.9
13.5	1	4	78.18
21.5	1	5	45.43

filtered
18.77
16.87

Notes:

* The filter used was a coffee filter.

11:03 ph 4.45 Temp 10.8

* Rapid test 1 Tad
1 Tad 115.6 NTU

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 3

WENCK ASSOCIATES
Responsive partner. Exceptional outcomes.

Date: 10-31-16

Site: Nemadji Area (Knowlton Creek) (synthetic Sample with soil sample and Distilled water)

Indicate Field Analyst(s):
- Kirby Templin (Wenck Associates, Inc.)
- ~~Louis Sigtermans (Wenck Associates, Inc.)~~
- ~~Jeff Strom (Wenck Associates, Inc.)~~
- Other Rebecca Forman

Product Tested: SCI-CW-A0 (Standard Contracting)

Significant Reaction? (Y) N

Mixing Method: Rapid Mix (Shaking)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	2:15	14.4	8.93	224.1	164.6

Dosing Table:

Starting Time (clock): 1:25pm

3:40pm 188.1 NTU

Time (min)	Dose Added (Spoon - Drop)	Cumulative Dosage (Spoon - Drop)	Pre-filter Turbidity (NTU)
0	2	2	
0.5	2	4	95.3
6.5	2	6	531.3
12.5	2	8	454.5
18.5	2	10	316.8
27	3	13	282.4
33	3	16	226.1
39	4	20	184.1
46	8	28	224.1 → 164.6 filtered

Notes:

* The filter used was a coffee filter.

11:05 ph 7.87 Temp 10.8

* Rapid test 2 Tads
1 Tad ≤ 30.9 NTU

Mixing Guidance:

• Add 1 Drop (Measurement Spoon) to sample bottle, close lid, and shake for 5 seconds. Let sit to react for remainder of 30 seconds. If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 5

Responsive partner.
Exceptional outcomes.

Date: 10-31-16

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Rebecca Forman

Site: Nemadji Area (Krowlton Creek) (Synthetic Sample with soil sample and Distilled water)

Product Tested: Liquifloc 1% (Dober)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? (Y) N after long settling

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	2:00pm	13.8	8.6	183.0	118.6

3:40pm, 28.94 NTU

Dosing Table:

Starting Time (clock): 1:08

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	1	1	
1	1	4	
2	1	6	
3	3	9	
4	3	12	
5	4	16	
6	4	20	854.9
13	4	24	497.0
20	5	29	333.2

started to floc.

time	added	total	NTU	final
26	5	34	185.[illegible]	
32.5	5	39	230.1	
39	5	44	183.0	118.6

Notes:

* The filter used was a coffee filter.

11:10 pH 7.8 Temp 10.8

* Rapid Test 15 drops + 15 drops 10 drops 347.9 NTU

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 1 minute. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

Test # 7

Responsive partner. Exceptional outcomes.

Date: 10-31-16

Indicate Field Analyst(s):

Kirby Templin (Wenck Associates, Inc.)

~~Louis Sigtermans (Wenck Associates, Inc.)~~

~~Jeff Strom (Wenck Associates, Inc.)~~

Other Rebecca Forman

Site: (Nemadji Area) (Nowlton Creek) (synthetic sample with soil sample and Distilled water)

Product Tested: Biostar-CH 2% (Hild and Associates)

Significant Reaction? (Y) N

Mixing Method: Slow Mix (Stirring)

Reduction to < 50 NTU? Y (N)

Sample Parameters:

Reading	Time (clock)	Temp (°C)	pH	Pre-filter Turbidity (NTU)	Post-filter Turbidity (NTU)*
Initial (Control)					
Final	3:31	15.2	8.7	216.4	171.8

Dosing Table:

Starting Time (clock): 2:40 4:00pm 107.1

Time (min)	Dose Added (Drop)	Cumulative Dosage (Drop)	Pre-filter Turbidity (NTU)
0	3	3	
1	3	6	
1.5	3	9	71000
7.5	3	12	936.3
13.5	3	15	758.9
19.5	3	18	626.4
25.5	4	22	412.8
31.5	5	27	289.5
37.5	5	32	254.3
43	5	37	216.4

171.8 filtered

Notes:

* The filter used was a coffee filter.

11:10 ph 8.05 Temp 10.7

*Rapid Test 15 + 15 237.1 NTU

Mixing Guidance:

• Add 1 drop and stir for 5 seconds. Let sit to react for remainder of 30 seconds. If no reaction is noticed, repeat.

If reaction is noticed, wait remainder of 5 minutes to test the turbidity (Allows floc to settle). Repeat until desired results.

APPENDIX I
PHOTOS

Technical Memo

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

To: Dwayne Stenlund and Bruce Holdhusen, Minnesota Department of Transportation

From: Kirby Templin, Jeff Strom, and Louis Sigtermans, Wenck Associates, Inc.

Date: March 3, 2017

Subject: Photos Memorandum

This memo includes photos taken throughout the course of the study of field sampling and testing, and photos of the samples test results.

1. Field Sampling and Testing Photos

Photo 1. Tailgate Test Kit being used in the field

Photo 7. Field equipment used for tailgate test
(left to right) Stopwatch, turbidity meter, plastic disposable pipette, and pH meter

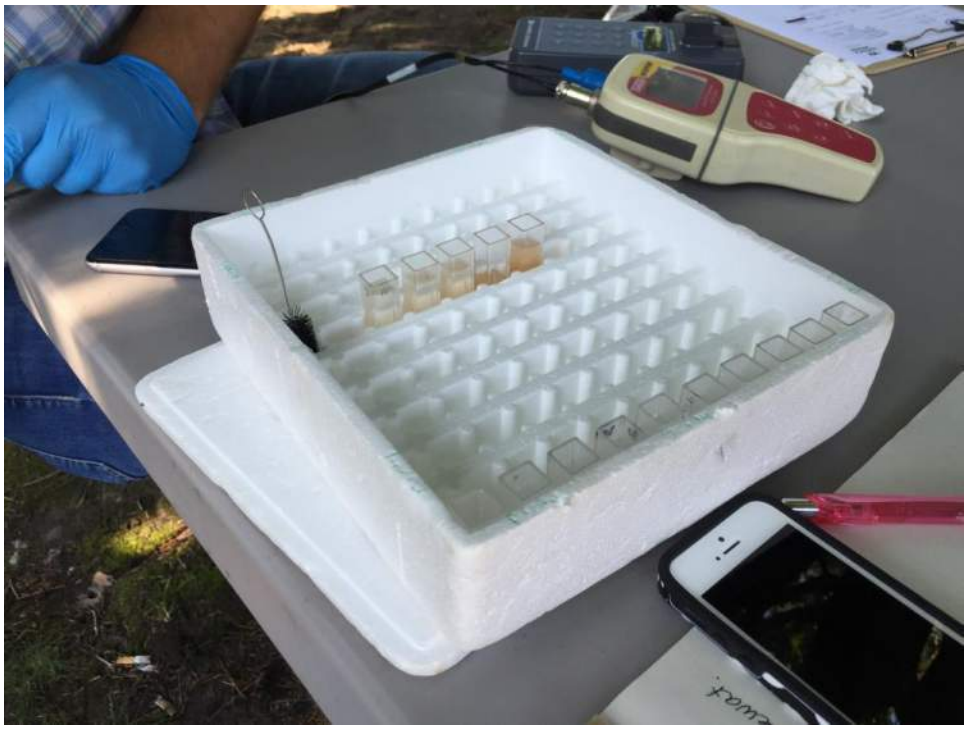


Photo 5. Samples in plastic cuvettes to be measured by a turbidity meter

Photo 3. Field analysts performing a test with the Tailgate Test Kit

Photo 4. Field analyst adds dry powder product to a sample

Photo 6. Dry powder product is added to a sample using a drop measuring spoon

Photo 8. Field analyst collects a grab sample or construction stormwater runoff

Photo 9. High turbidity construction stormwater runoff

Photo 10. High turbidity runoff in a ditch at a construction site

Photo 11. Construction site after recent rainfall event

Photo 12. Dewater activity at a construction site

Photo 13. Construction stormwater discharged from a dewatering pump

Photo 2 – Settling Tank for construction stormwater discharge

2. Sample Test Results

Photo 15. Sample 2 Results (Highway 53)
Tests #1-13 in order from left to right

Photo 19. Sample 3 Results (St. Paul Technical College)
Tests #1-13 in order from left to right

Photo 16. Sample 4 Results (Highway 371)
Tests #1-13 in order from left to right

Photo 14. Sample 5-1 Results (Highway 36 and Lexington Ave)
(left to right) Tests # 1, 2, 3, 5, and 7

Photo 17. Sample 6 Results (Highway 96)
(left to right) Tests # 1, 2, 3, 5, and 7

Photo 18. Sample 7 Results (Nemadji)
(left to right) Tests # 1, 2, 3, 5, and 7

Responsive partner.
Exceptional outcomes.